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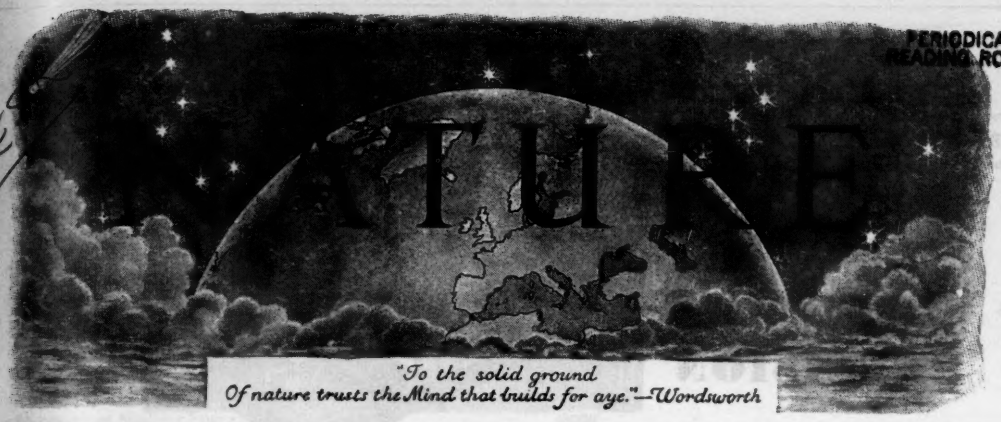

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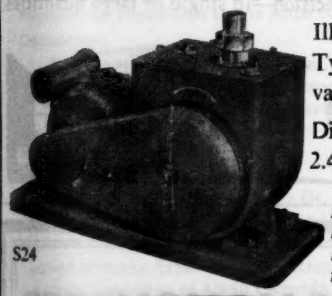

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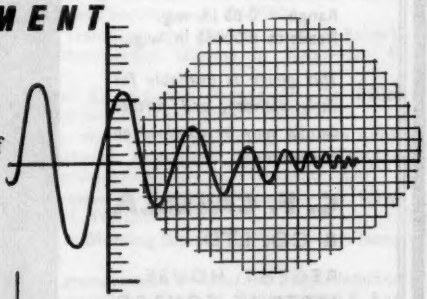

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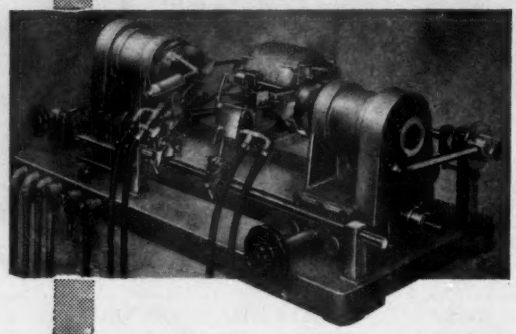

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NATURE

No. 4588 SATURDAY, OCTOBER 5, 1957 Vol. 180

CONTENTS

	Page
Social Implications of Automation	669
Evolution and Theology. By The Rev. Dr. E. L. Mascall	671
High Polymers. By Prof. C. E. H. Bawn, C.B.E., F.R.S.	672
Economics of Nuclear Energy. By C. A. Rennie	673
Distinguished Thermodynamics. By Prof. N. K. Adam, F.R.S.	673
Documentation and Dissemination of Information. By Prof. S. I. Tomkeieff	674
The Large-scale Structure of the Galaxy. By F. J. Kerr, J. V. Hindman and Martha Stahr Carpenter	677
Biogenesis of Natural Products. By Prof. A. J. Birch	679
Constitution and Care of the Infant Animal. By Dr. E. M. Widdowson	681
Physiological Expedition to the Antarctic. By Dr. L. G. C. E. Pugh	683
Obituaries :	
Prof. G. H. Wooldridge. By Prof. J. McCunn	683
Mr. Leo Bagrow. By R. A. Skelton	684
Mr. James Kendall. By L. Rotherham	684
News and Views	685
Bilingualism in Education	689
Research on Gelatin and Glue. By Dr. G. R. Tristram	690
Control of Chemical Additives in Food	692
Morale in Industry. By T. H. Hawkins	694
Control of Public Expenditure on Scientific Projects	695
A Lattice Distortion of Alkali Chloride Crystals in the Presence of Nucleoprotein Microfibrils. By J. C. White, P. C. Elmes, V. Balashov, Prof. R. D. Preston, F.R.S., and G. W. Ripley	696
An Inherent Character of Plant Species of Drier Habitats. By Dr. M. L. R. Pettersson, S. K. F. Ellis, G. E. J. Gray and R. S. Smith	698
A Carotene-Protein Complex isolated from Green Leaves. By Mitsuo Nishimura and Ken Takamatsu	699

Letters to the Editors :

Mass-Spectrometric Assay of Elementary Nitrogen.—Dr. J. B. Capindale and Dr. D. H. Tomlin	701
Aerodynamic Drag of Perforated Plates.—J. R. D. Francis and P. Minton	702
High-Efficiency Columns for the Analysis of Hydrocarbons by Gas–Liquid Chromatography.—R. P. W. Scott and J. D. Cheshire	702
Electric Strength of Unsaturated Hydrocarbon Gases.—Dr. A. E. D. Heylen	703
Occurrence of Gamma-Guanidinobutyric Acid.—F. Irreverre, R. L. Evans, A. R. Hayden and R. Silber	704
Conical Paper Chromatography.—Dr. Yoshinobu Osawa	705
A Diurnal Cycle in the Mitotic Activity of Ascites Tumour Cells in Mice.—Dr. I. P. S. Agrell and Elsa Welin-Berger	705
Teratogenic Effects of Beta-Amino-Propionitrile in the Chick Embryo.—Ellis E. Rosenberg	706
Sodium Ions and Tissue Metabolism : Some Metabolic Peculiarities of Brain Tissue.—Genkichiro Takagaki and Yasuzo Tsukada	707
A Non-Destructive Technique for locating Amino-acids.—E. R. Cook and M. Luscombe	708
A Route for Intravenous Injection in the Albino Rat.—Kenneth A. Pearce	709
Intracellular Recording from Spinal Motoneurones following Stimulation of Medullary Pyramids.—Dr. Roger Merritt Morrell	709
Differentiation of Somatic and Autonomic Nerve Fibres in Tissue Sections.—A. D. Dixon	709
Attempt to transplant the Œdema Fluid of Experimental Inflammatory Œdema in Rats.—Dr. E. Kelemen	710
A 'New' Kell Blood-Group Phenotype.—Dr. Bruce Chown, Marion Lewis and Kiroko Kaita	711
Differences in the Food of the Young and the Adult Indian Mackerel, *Rastrelliger kanagurta* (Cuv.).—K. V. Narayana Rao and Dr. K. Pampapathi Rao	711
Quantal Responses to Mixtures of Drugs.—P. S. Hewlett and R. L. Plackett	712
Homoserine in Bleeding Sap of Pea Plants.—Dr. Janny A. Bakhuis	713
Abnormal Metamorphosis in Saturniid Moths Infected by a Microsporidian.—Dr. L. H. Finlayson and V. Ann Walters	713
Vernalization of Green Plants of a Winter Wheat.—Dr. M. B. Gott	714
Cytology of Indian Species of *Onychium*.—P. N. Mehra and S. C. Verma	715
The 'Dawn Chorus' in Radio Observations.—G. A. Isted and G. Millington	716

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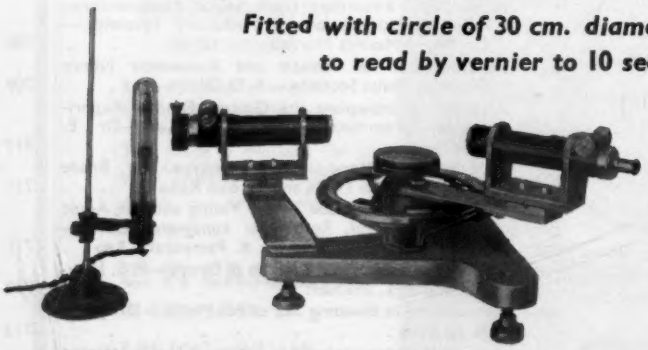

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SOCIAL IMPLICATIONS OF AUTOMATION

A PASSAGE in the report of the Advisory Council for Scientific and Industrial Research for 1955–56 refers to the sponsoring of research into the social and economic implications of automation, and pertaining to the work of the Department in stimulating thought and further studies of the human and psychological element in the partnership between employed, employer and consumer, especially with the view of removing frustrations which hamper good industrial relations. Such studies are at present the responsibility of the Department's Intelligence Division, advised by the Committee on Economics and Industrial Operations set up early last year under the chairmanship of Prof. E. A. G. Robinson; and on the advice of this Committee the Department placed a contract with Political and Economic Planning for a case-study of automation in a large firm. Three such case-studies have recently been published by PEP*, one of which, on the manufacture of bearing tube, was undertaken for the Department of Scientific and Industrial Research.

All three studies were undertaken to obtain impartial and dispassionate close comparisons of methods and operations before and after the introduction of automatic techniques, so as to bring out the technical, economic and managerial consequences of automation and the problems to which it gave rise. The report does not attempt to generalize from the evidence obtained, though it may be said that on the whole it supports the report on automation issued by the Department last year. All three studies bring out the increased importance of planning when more automatic methods are used, both for the introduction of new methods and for more detailed day-to-day guidance of operations when the automatic equipment is in use. They do not, however, indicate that detailed and accurate forecasts of future requirements will be any more available to a firm installing automatic equipment than to other firms. Business forecasting is thus of increasing importance, while the need for more careful planning involves a higher proportion of management and supervisors in the total labour force. The proportion of maintenance workers to operatives also had to be increased, new and higher skills being required to maintain the new equipment.

The most important results and advantages of the automatic methods appear to have been in the realm of technical improvements. In the tube study, more variable sizes and tolerances are affected. It seems inconceivable that the 'Platformer' studied at Stanlow could operate without automatic process control, while some of the greatest advantages of Lyons Electric Office, commonly known as the 'Leo' computer, have been the provision of more information more quickly and accurately. These are results not easily evaluated in economic terms, though they may be more important than the direct financial advantages which can be calculated. The increased productivity arising from the changes was, however, well proved, amounting to something more than 200 per cent in the tube-making case study, while Leo can do the work of 200–400 clerks per shift with a very much smaller number of operators, maintenance engineers and programmers.

The only redundancy discovered in these three studies occurred during the change-over from the old to the new methods, and has not proved a permanent feature; but at the same time it is emphasized that skills have changed and men have had to transfer from one job to another. Re-training has been necessary, but the evidence is that for most of the operating staff this has not presented serious problems. So far as the new maintenance skills are concerned, the difficulty has been to obtain a supply of men with the right qualifications or experience. Training of maintenance workers is an important matter to which much effort has been devoted.

Some of the old manual skills have been eliminated by the use of more automatic methods, and piece-rates have been rendered obsolete; but the evidence does not suggest that the operative has been made more subservient to the machine. The men in the new tube mill need perceptual skills, and while conditions of work have improved it appears also to be true that satisfaction in work has increased. The operators of the Platformer need, too, conceptual skills, and they have to monitor it intelligently. Furthermore, the operators of the tube mill exercise a considerable degree of personal intervention in the process, and must work as a team to get the best results; this new type of team-work, required when automatic methods are used, is probably the most important theme running through these three studies. Management, supervisors, operatives and maintenance engineers appear to become very much part of one team, the members of which must work together if the best is to be obtained from the new machinery; in this there is hope that social gain may accompany economic advance.

The three studies were chosen to be as representative as possible of the different types of automatic production; but Political and Economic Planning emphasizes that no sweeping deductions can be drawn from this evidence, and in particular that the reassuring evidence on redundancy cannot be applied over the whole of industry. Although, for example, the study of Leo indicated that the electronic office has not so far resulted in redundancy, this does not mean that use of electronic computers in industry, commerce and administration will never cause redundancy. This particular computer was chosen for study because it is the computer with the largest history of successful application to routine clerical

* Three Case Studies in Automation. Pp. vi+58. (London: Political and Economic Planning, 1957.) 7s. 6d.

work in Britain. The manufacture of bearing tube by the Tube Investments Group was chosen as offering a good direct comparison between an old plant still in operation and a new mill, the Assel Elongater, while the Stanlow Platformer was chosen as a good example of modern refinery practice.

One of the most interesting features of these studies is the way in which they underline much of the argument of the Earl of Halsbury, both in his paper last year before the Royal Society of Arts and in those he has since contributed to *Impact*, particularly that on integrating social with technological change. This aspect he considered to some extent in his paper in *Impact* of December 1956, where he emphasized the psychological problems requiring attention, and pointed out that if a man's occupation was transformed by a machine, he should be given the chance to be the man to work the machine if he can; if his skill is rendered redundant by the whole complex of action by managements, designers, technologists, scientists and others, those actions should include re-establishing him at his old earning power, and the cost of doing so should be part of the true cost of the technical development rendering him redundant. Lord Halsbury recognized the danger of industrial society becoming divided into two hostile sub-groups—a managerial group relatively free and a worker's group relatively bound, and that it is essential to accumulate dispassionately the facts which could give manager and worker an objective picture of one another and promote goodwill and trust.

In a more recent paper, in the March issue of *Impact*, Lord Halsbury analyses more particularly the antagonism between these two groups, which, he suggests, should be the first concern of industrial psychology. Four sets of explanations are required: (*a*) of the worker to the manager; (*b*) of the worker to himself; (*c*) of the manager to the worker; and (*d*) of the manager to himself. But so far study has been concentrated on the worker with the view of giving the manager an authoritative picture of the worker's needs. The findings in this context have already been largely adopted in practice by the best employers, and further concentration on this aspect is unlikely to be rewarding; though Lord Halsbury stresses the courage and tact required to investigate the mentality of the employer and to get the worker to see himself objectively.

This is a programme for long-range fundamental research, nor can it be certain that the knowledge when won will be applicable. Meanwhile, every effort should be made to raise conditions of employment generally to the level of the best, and Lord Halsbury points out that managers should recognize that the failure of friendly efforts to remove distrust or aggressiveness may well be due to this gap in our knowledge. Again, empirical efforts to promote freedom at work should be more thoroughly explored, and technical progress should be watched for signs of anything that may alleviate environmental conditions. Above all, he insists we must be ready to introduce corrective factors in unforeseen situations before those situations deteriorate. The trend towards automation, for example, must increase general synchronism between one worker and another, and it would thus be possible to displace stresses arising from the monotony of the sub-divided repetitive task and the assembly line on to maintenance engineers responsible for the upkeep of the transfer line and the automatic assembly units. Probably every solution in this field is a compromise, but intelligent anticipation at least offers a choice between the better and the worse.

Whether or not the Department of Scientific and Industrial Research is the appropriate focus to which the organization for research in Britain on these studies of the human aspects of automation should be brought is a large question; and although the National Institute of Industrial Psychology has now taken its place among the institutions which receive grant under the research association scheme, the question should not be regarded as settled. It is, of course, not easy to draw a sharp distinction between the more mechanical aspects of productivity and the human aspects of such problems; but the argument for a social and economic research council seems somewhat stronger than when the proposal was advanced more than ten years ago.

The very different approach to problems of automation and productivity which marks an article by Mr. S. B. Bailey in the *Westminster Bank Review* of August seems to point in the same direction. Mr. Bailey is concerned particularly with some lessons we might learn from the United States regarding productivity and incentives. He points out that with a smaller population, lower wages, higher selling prices and purchase tax, the demand in Britain for many mass-produced goods is much less than one-tenth of what it is in the United States. Accordingly, with smaller production quantities, it would not be economic to mechanize production methods to the extent common in the United States; but without such automation we cannot hope to equal American productivity and thus attain her standard of living. The wages of the British worker could be doubled or trebled, he suggests, if his productivity equalled that of the American worker; but as the case studies of automation confirm, the necessary equipment could only be economically installed if run to capacity, for example, on double shifts, and it would also be essential for the worker to abandon restrictive practices and co-operate fully to take advantage of the new methods.

Mr. Bailey is highly critical of retail trade in Britain, in which, he suggests, we have made ourselves a nation of price-fixers in contrast to a robust nation of keen buyers and shopkeepers in the United States, and also of taxation policy in Britain, particularly purchase tax. Our economic troubles he considers arise largely from lack of competition and incentives, and the European Free Trade Area may give British manufacturers the spur they need; and if traders were freed from re-sale price control there would be an additional powerful stimulus to efficiency. He

insists that while the benefits of the welfare State are attracting to the shores of Britain the unskilled who can just earn their own keep, our taxation policy is driving away the highly skilled and creative worker whose efforts create employment for thousands. He does not agree with the view of the Overseas Migration Board in its second report, that the rate of loss of professional engineers does not give cause for alarm, and argues that we cannot afford to export to North America more than 10 per cent of our annual increment in professional and mechanical engineers.

Lord Halsbury entitled one of his papers "Automation—Verbal Fiction, Psychological Reality"; and this group of studies and papers is to be welcomed as a contribution to the realistic thinking needed if the potentialities of automation for productivity and for economic and social advance are to be realized. They indicate clearly the openmindedness and adaptability which will be required at all levels, from that of the Government downward, and the wide implications of the whole process, as well as the large field for social and economic research. It is perhaps above all as a contribution to the immense task of education which must proceed with, and to some extent precede, the introduction of automatic methods that they are most welcome. While they are not specially addressed to the scientist, he will find in them much to encourage the application of scientific method and ways of thought to problems that are technical as well as economic and social.

EVOLUTION AND THEOLOGY

Evolutionary Theory and Christian Belief

The Unresolved Conflict. By Dr. David Lack. Pp. 128. (London: Methuen and Co., Ltd., 1957.) 10*s.* 6*d.* net.

THIS must be as impartial a book as has ever been written on a highly controversial problem. It is notable in addition for the exhaustive knowledge which its author shows of the relevant literature both past and present, and one is agreeably surprised to discover that, even when the battle between evolutionists and religious spokesmen was at its fiercest, there were thinkers on both sides who were able to distinguish between the real and the spurious issues, and to keep both their heads and their tempers. Dr. Lack shows an admirable restraint in refusing to decide issues when the evidence is insufficient, and, if at the end he leaves open the question of the relation between evolutionary theory and Christian belief, from the point of view of the scientist, it is with the explicit recognition that biology provides as little positive support for scientific humanism as for Christianity. On two points only he commits himself definitely: first, that natural selection is able to account for the main features of evolutionary change, and secondly, that evolutionary theories of ethics are inadequate. The latter conclusion is reached, it should be noted, on philosophical rather than scientific grounds, and it may be added that Dr. Lack is more competent than many distinguished scientists have been in handling philosophical arguments.

No sensible theologian will want to build the temple of religion on the shifting sands of contemporary science, but it is worth remarking that the traditional Christian account of man's origin and predicament seems to be far more compatible with modern biology than are the outlooks of so-called liberal Christianity. The doctrine that sin began in a pre-human realm, with the fall of angelic beings one of whose functions was the supervision of the material world, was not elaborated in order to explain why the universe was disorganized before the appearance of man, a fact which at the time was unsuspected; it is therefore all the more impressive that it performs this function. Again, while evolution makes it practically impossible for us to hold that bodily death in general was the consequence of man's fall, it offers no obstacle to the view that, in Dr. Lack's words, "if the Fall had not occurred, man's physical nature was to be miraculously changed, so that he was to become immortal and no longer subject to biological limitations" (p. 79); and it is this, and not the view that man was *naturally* immortal, that is the traditional doctrine of Christian theology. Even if we may regret the present Pope's denunciation of polygenism, we must admit that most contemporary anthropologists would agree with him on this point. However, I have dealt with these questions more fully elsewhere, in my "Christian Theology and Natural Science".

Finally, we may raise the question whether evolution by natural selection is any less congenial to Christianity than are views which hold the universe to be penetrated by some kind of entelechy or *élan*. We are told that there are in the universe something like 100 million galaxies, each containing something like 100,000 million stars, many of which no doubt are accompanied by planets forming possible sites for the appearance of living beings. Furthermore, when we examine the only one of these sites with which we have direct acquaintance, we see that the main line of evolution, that which leads up to man, has threaded its way through innumerable points of bifurcation, at each of which the side road was fated to run into a dead end of over-specialization or inadequate adaptability. In this gigantic universe man, for all his presumed uniqueness, thus appears as one of those occasional oddities, like the yarborough at cards, which are bound to turn up occasionally if you set going a sufficiently enormous number of random processes; as in fact the product of chance rather than of design. Suppose, however, that God uses just this method of 'chance' in order to produce here and there the occasional physical organism which, by its organic adaptability and its cerebral complexity, is an adequate counterpart for a rational and spiritual soul. Admittedly, this method will seem outrageously wasteful to the economical mind of bourgeois man, who will expect a God to whom all things are possible to reach His ends in a simpler and tidier way. However, a Being whose resources are unlimited has no need to be governed by considerations of economics, and He will in any event be glorified by the 'dead ends'—the dinosaurs and ants and bacteria—as well as by the beings into which He has infused a rational soul. Perhaps some modern theologians have gone badly wrong in looking for evidences of large-scale design in the universe. The truth may be that God is great enough to be able to achieve His ends without that kind of design; it is at least significant that 'cosmic

teleology' is a modern feature of Christian apologetics which is not found, for example, in St. Thomas Aquinas.

This book is of much greater importance than its size would suggest. It would provide admirable material for group-discussion on all levels of philosophical competence. E. L. Mascall

HIGH POLYMERS

Textbook of Polymer Chemistry

By Fred. W. Billmeyer, Jr. Pp. viii+518. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1957.) 10.50 dollars.

Polymer Processes

Chemical Technology of Plastics, Resins, Rubbers, Adhesives and Fibres. Edited by Calvin E. Schildknecht. (High Polymers: a Series of Monographs on the Chemistry, Physics and Technology of High Polymeric Substances, Vol. 10.) Pp. xvii+914. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 19.50 dollars.

Chemistry of High Polymer Degradation Processes

By Dr. Norman Grassie. Pp. xv+335. (London: Butterworths Scientific Publications; New York: Interscience Publishers, Inc., 1956.) 42*s*.

The Chemistry of Phenolic Resins

The Formation, Structure, and Reactions of Phenolic Resins and Related Products. By Robert W. Martin. Pp. xi+298. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 76*s*. net.

THE unique properties which high polymers possess and which distinguish them from other substances are associated with the concept that the polymer molecule is built up of a structure very many times greater than those occurring in simple substances. Although this viewpoint—which did not receive acceptance until the 1930's—had a profound influence on the development of polymer research, it was not until the 1940's that suitable methods were developed for the full quantitative study of the relationships between polymer properties and constitution. The immense technological development which has followed from these discoveries has had a tremendous impact on our daily lives and the chemical and engineering industries. All but a few of the wide variety of synthetic polymers now in use have been developed during the past two decades. The beginnings of the plastics industry, however, go back long before the establishment of the principles of synthesis. Vulcanized rubber was commercialized one hundred years ago, and cellulose derivatives and the phenol formaldehyde resins were developed industrially in the early part of this century.

The field of polymer science and the progress in polymer technology is still growing very rapidly and the books under review cover various aspects of the chemistry of polymeric substances.

Dr. F. W. Billmeyer's text-book summarizes and classifies the more interesting and important information about the organic and physical chemistry of high polymers. It is written for graduate-level students who desire to specialize in this subject. The fifty-seven relatively short chapters may be divided broadly into four parts: physical chemistry of high polymers (1–18); kinetics of polymerization (19–31); plastics (32–43); and fibres and elastomers (44–57). Although the basic principles are formulated in a clear and elegant manner, the author seems to attempt too much in that, in addition to a fundamental theoretical treatment, the properties of the main types of plastic, rubbers and fibres, together with the short descriptive account of polymer processing and other technological procedures, are summarized. For those who prefer the theory and practice in one volume the book fills this need. It is certainly one of the best general text-books yet produced.

"Polymer Processes" is written by an outstanding group of authors, all having long experience in their respective fields. The book deals with the chemical aspects of polymer technology and especially the newer processes of the preparation, formulation and shaping of plastics, rubbers, fibres and adhesives. The earlier chapters deal with the important methods of laboratory and plant processes by which olefinic monomers are polymerized, namely, bulk suspension, emulsion and solution. The next chapters summarize in detail the preparation and properties of the polyamides and polyesters, cellulose and cellulose derivatives—epoxy resins, polysulphide polymers, new adhesives, condensation with formaldehyde. The remaining section of the book deals with recent advances in the chemical technology of polymers, namely, paste and latex techniques, compounding and processing of rubbers and resins, polymer reinforcement and spinning and drawing of fibres. The book bridges a gap between theory and practice, and throughout the various chapters recent developments of both theoretical and practical interest are emphasized. The editor, Dr. C. E. Schildknecht, who himself contributes three excellent chapters, has succeeded in demonstrating the contribution of theory to technical advance.

The degradation of high polymers is of interest for two reasons. On one hand controlled degradation is of technical importance in the processing of polymeric materials, as in the milling of rubber or the hydrolysis of polysaccharides. On the other hand, a knowledge of the conditions and mechanism of degradation is of importance technically, as it determines the surface behaviour of the polymer and the limiting conditions under which it can be fabricated. A study of these processes has led to the introduction of more useful types of polymers and the development of methods of stabilization and protection during fabrication. Dr. N. Grassie's book provides an excellent account of our present knowledge of polymer degradation reactions. He discusses not only the types of reactions which occur within the environment of polymer chains but also the elementary reactions which make up the composite change occurring during the degradative reaction. Thus, in separate chapters he describes studies on model compounds such as the oxidation of olefines, sulphurization and ozonization, ester decompositions, etc., which although they cannot be included within the term degradation are of vital importance in elucidating the reactions of rubbers and synthetic fibres. In bringing the facts together in a systematic manner Dr. Grassie has established certain general principles which will be of immense value in the further understanding of this subject.

The phenolics constitute the oldest and most studied group of thermosetting resins, and interest

in these materials has steadily grown since the outstanding studies of Baekeland at the beginning of the century. The interest in the technology of the resins during the early days of the phenolic resin industry far overshadowed interest in the chemistry involved or in the pure chemicals that might be obtained by proper control of the reaction conditions. However, as the resin technology developed and the applications of the resins became more specialized it became necessary to know more about the mode of formation, factors which determine resin properties, cure, etc. It is the latter considerations which are dealt with in Dr. R. W. Martin's book. The chemistry of the preparation and structure of the phenol-aldehyde reactions is discussed in detail. Other sections review the chemistry of the cure of phenolic resins, the joint reactions of phenols and aldehydes with an added reagent, the formation of cyclic products and the reactions of the phenol-aldehyde products, and the final chapter summarizes the results obtained from reaction-rate studies. The book presents for the first time under one cover the present-day chemistry of phenolic resins and related products, and although written mainly for the resin chemist the emphasis is always directed to the nature of the chemical process occurring rather than the application. The book is a valuable survey of the subject and will be most useful to resin chemists, technologists and others interested in the wider chemistry of polymers.

C. E. H. Bawn

ECONOMICS OF NUCLEAR ENERGY

The Economics of Nuclear Power including Administration and Law

Edited by J. Guéron, J. A. Lane, I. R. Maxwell and J. R. Menke. (Progress in Nuclear Energy, Series 8.) Vol. 1. Pp. xiii+513. (London: Pergamon Press, Ltd., 1956.) 120*s*. net.

THIS book, which is one of the series issued by the Pergamon Press on "Progress in Nuclear Energy", is well produced and well printed, and contains a mass of information. The book is divided into five sections, of unequal length. The first section, on the needs and resources of energy, occupies the first third of the book. The next three sections, on nuclear power economics, on nuclear fuel cycles, and on reactor programmes and reactor economic data, occupy the middle third of the book, while the last section on administration and law occupies the remainder of the book, together with an adequate index.

The first part of the book, on energy needs and resources, contains general papers dealing with fuel reserves, rates of growth of power requirements and possible uses of nuclear energy, and in addition there is a selection of papers summarizing the energy position in some countries. The general papers on this subject form a convenient source of reference information on the energy requirements of various countries. Similar information is available in other papers, but it is probably true to say that it is expressed as concisely here as anywhere.

In the middle section of the book, dealing with the economics of nuclear power stations, one gets on to ground which is much less firm. It is here that there is a shortage of facts, and a surfeit of predictions. This, of course, is no fault of the book, but a natural consequence of the newness of the whole field of nuclear power. Not until more information is available from nuclear power stations that have actually operated will it be possible to decide which of the predictions are true, and which are not. The shortage of facts refers not only to the actual cost of reactors, but also to the costs of fabrication of fuel and all the other processes which go to make up the complete nuclear fuel cycle. This question of nuclear fuel cycles is well covered by the papers in the third section of this book.

The last section of the book, on administration and law, brings together a number of papers dealing with the various problems that have arisen, which are specific to the use of atomic energy. The papers given here illustrate the position which has been reached in the various countries actively concerned with the development of atomic energy. It is apparent from these papers that while every attempt is being made to produce codes of practice similar to those used in older and more established industries, this is proving a difficult problem.

Although the majority of the information in this book was given at the Geneva Conference in 1955, it is not for that reason particularly out of date, for whereas much more has been written on the subject since then, there has not been any significant change in the position. The prototypes of some forms of nuclear power reactors have now come, or are now coming into operation, but it is still too early to obtain a comprehensive picture of their true costs, and in any event these first models are prototypes and are not the same as the reactors which will be built for large-scale power generation.

C. A. Rennie

DISTINGUISHED THERMODYNAMICS

Thermodynamics

An Advanced Treatment for Chemists and Physicists. By Prof. E. A. Guggenheim. Third edition. (Series in Physics.) Pp. xxiii+476. (Amsterdam: North-Holland Publishing Company, 1957.) 34.50 guilders.

THAT a third edition of Prof. E. A. Guggenheim's "Thermodynamics" has appeared barely eight years after publication of the first edition is proof that its unique merit as a comprehensive, logical, and coherent treatise is widely appreciated. The subject is presented as a mathematical system, starting from a few fundamental quantities, one of which is entropy. Entropy and absolute temperature are introduced together, and neither is defined in terms of anything supposedly simpler, for the author does "not admit the existence of any simpler thermodynamic quantities". This approach has logical advantages, but most beginners will need more help than is given here in relating entropy, at any rate, to more familiar physical quantities.

To those who already have some knowledge of thermodynamics, this book will be a treasure house of methods and results, invaluable to chemists particularly, but also to physicists. The topics dealt with include one-component systems, mixtures, including dilute solutions and solutions of electrolytes, chemical reactions, galvanic cells, systems in gravitational, electrostatic, and magnetic fields, and radia-

tion. The treatment of the thermodynamics of surfaces is original and a marked advance on previous treatments.

Naturally much of the material presented has been well known for a long time, but Prof. Guggenheim imparts his own clarity and individual flavour to the argument everywhere; and his comments on commonly used methods and conceptions are always illuminating, often critical, and sometimes pointedly disapproving. He considers the time-honoured practice of using "heat of reaction" to denote the heat given out in a reaction "deplorable"; but many may think that the old sign convention, by which the heat of combustion of coal, or heat of fission of uranium, are large positive quantities, should not be abandoned merely to make the symbol for heat of reaction ΔH instead of $-\Delta H$.

There are several changes since the first edition, mostly in the treatment of solutions. Solutions with many components are discussed along with two-component solutions, instead of in a separate chapter. Prominence is now given to Scatchard's 'excess functions' as an alternative to activity coefficients or an osmotic coefficient, for expressing the deviation from ideality of solutions. The osmotic coefficient φ, used in this edition, is not identical with the osmotic coefficient g used formerly, although it becomes equal to g at great dilution. The author has apparently abandoned the use of an osmotic coefficient except for very dilute solutions, which seems a pity. Following Hildebrand's desire to restrict the term 'regular' solutions to those where the entropy change on mixing is that for ideal solutions, a new term, 'simple' solutions, has been introduced to describe most of those called 'regular' in the earlier edition; and the existence of truly regular solutions, apart from ideal solutions, is now challenged. The rather unexpressive term 'degree of advancement' has been changed to the clearer 'extent of reaction'. There is a new chapter on Onsager's reciprocal relations.

Though the book deals mainly with classical thermodynamics, the results of statistical thermodynamics are frequently used, though often only an outline of the statistical argument is given. The book is thoroughly up to date and authoritative, and the thought-provoking challenges frequently thrown out to customary conceptions and methods which may lack precision are salutary, even though not all the criticisms will necessarily be accepted as valid.

N. K. Adam

DOCUMENTATION AND DISSEMINATION OF INFORMATION

Documentation in Action

By Jesse H. Shera, Allen Kent and James W. Perry. (Based on the 1956 Conference on Documentation, at Western Reserve University.) Pp. xv+471. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1956.) 80*s*. net.

As the sub-title suggests, this book is based on a symposium on documentation, but the implications of the subject may not be very clear to potential readers, particularly those on the eastern side of the Atlantic. The purpose of the book is to promote the widest possible dissemination of information. The method is to discuss in original articles and programmes existing and envisaged systems and equipment for storing, classifying and correlating recorded material with the view of ensuring its maximum availability and therefore potential value.

As J. H. Shera points out in the introduction, "The world of thought (scholarship) and the world of action have always been interdependent", and this means that to provide for an efficient human society we require to build up an efficient scheme of communications. At the present time with the rapid increase of knowledge, and even more rapid increase of the volume of publications, this need is becoming even more imperative than before. The newly emerging science, dealing with the organization of human knowledge, which has not as yet received a distinctive name, includes a very large number of departmental aspects, such as linguistics, semantics, logics, philosophy, principles of classification, library organization, card systems and recording and calculating machines, organization of scientific societies and scientific and technical publications, abstracting and reviewing services, book production and many other matters. In the words of J. H. Shera: "The new discipline that we here envisage, and which for want of a better name we have called 'social epistemology', will provide a framework for the effective investigation of the whole complex problem of the intellectual processes of society—a study by which society as a whole seeks to achieve a perceptive or understanding relation to the total environment. It will lift the study of intellectual life from that of the individual to an inquiry into the means by which a society, nation, or culture achieves an understanding relationship with the totality of the environment, and its focus will be upon the production, flow, integration, and consumption of all forms of communication throughout the entire social pattern. From such a discipline should emerge a new body of knowledge about, and a new synthesis of the interaction between, knowledge and social activity".

The book consists of a number of original articles as well as discussions and co-operative programmes. Part 1 contains seven articles on documentation terminology, co-operative information processing, logic of research, librarianship, methods of storage and retrieval of information and on the use of information. Part 2 contains programmes for the future on the utilization of recorded knowledge, with six articles on abstracting, librarianship, and the role of language in the communication of recorded information. Part 3 contains seventeen discussions of the subjects raised in the articles. Part 4 contains five co-operative programmes, called 'co-operative information processing', for branches of science dealing with metals, pharmaceuticals, petroleum, documentation as such and patents. Machine translation, programmes of Unesco and mechanisms for flow and retrieval of research information are also discussed.

The choice of terms used in this book ('processing', 'project', 'language engineering' and the verb 'to programme') brings us into close contact with the American vitality of language and action; but this need not deter the scientist, or engineer, or anyone dealing with organized knowledge or administration from studying this book.

The problems it tackles are the outcome of the enormous increase in the rate of production in knowledge and the imperative necessity for utilizing it in the service of human society by developing efficient systems of 'communication'.

S. I. Tomkeieff

Birds of New Guinea

By Tom Iredale. Illustrated with Thirty-Five Plates in Colour, figuring 347 Birds, by Lilian Medland. Vol. 1: Pp. xv+230+plates 1–15. Vol. 2: Pp. xv+261+plates 16–35. Edition limited to 1,500 copies. (An Australiana Society Publication.) (Melbourne: Georgian House, Pty., Ltd., 1956.) 24 guineas the set.

THE great tropical island of New Guinea is remarkable for its ecological diversity. The coral coastlines support a lush strand vegetation that gives way to thick rain forests or occasionally (in the south) to savannah. There are great tracts of upland *kunai* grass-lands, and above these there are moss-forests. Over all tower the New Guinea Alps with their cover of permanent snow. There are, too, large rivers and extensive tracts of mangroves, as well as freshwater sago swamps, wide reed-beds and both coastal and upland lakes. These varied conditions support an extraordinary variety of birds and, in particular, great numbers of parrots, pigeons, kingfishers, cassowaries, megapodes ('incubator-birds'), honey-eaters, bower-birds, birds-of-paradise and other groups that reach their highest development on, or are restricted to, the Australian side of Wallace's Line.

There still remain large areas of New Guinea unvisited by Europeans, although the birds of many relatively accessible districts are rapidly becoming known. Until the appearance of Mr. Iredale's volumes, there was no single, comparatively non-technical, account of the country's avifauna as a whole. Mr. Iredale deals with some 650 species, of which 347 are presented in thirty-five beautiful colour-plates. One volume deals with non-passerine forms, and the other with passerines. The work contains a great deal of absorbing information; and it is unfortunate that it gives only the briefest references to other literature. It will be read with critical interest by systematists concerned with the Australasian region, and should be of high general value (and in particular a useful species identification) for New Guinea Europeans with a feeling for natural history. The production maintains the high technical standards of Georgian House. It is sad that the artist, Lilian Medland (Mrs. Iredale), did not live to see the publication of her exquisite pictures.

A. J. MARSHALL

An Introduction to Blood Group Serology

Theory, Techniques, Practical Applications, Apparatus. By Kathleen E. Boorman and Dr. Barbara E. Dodd. Pp. viii+317. (London: J. and A. Churchill, Ltd., 1957.) 40*s*. net.

IN 1940, blood grouping meant typing an individual's blood for ABO groups and perhaps occasionally titrating his serum for the corresponding anti-A and anti-B antibody. The other blood groups known at that time were the M, N and P groups, previously discovered by Landsteiner and Levine, and these tests were carried out in cases of disputed parentage. In 1940, Landsteiner and Wiener discovered the Rh group, and from then on a great change took place. A study of the Rh group showed it to be a complex group that was of considerable clinical significance apart from its importance in blood transfusion therapy, and despite war-time difficulties considerable progress was made in this study both in Britain and the United States during the years following 1940. Additional blood groups have now been discovered so that nine such systems are known. They have been found to be much more complex than was originally thought, and several blood group antibodies recently discovered have detected antigens which are related to one of the previously known blood group systems.

The term 'blood group' implies that an individual has on his own red cells a particular antigen. These react with the corresponding blood group antibodies, and it is the detection of these antigen–antibody reactions that constitutes blood grouping. Prior to 1940, saline agglutination techniques were used, but since 1940 many new techniques have been employed, and but for these the discovery of several blood groups could not have been made and the presence of the corresponding antibody in an individual's serum not suspected. These techniques constitute blood group serology, and it is with these practical matters that this book deals. It describes a large number of methods which are available for this work; the techniques are numbered and many different ones are described, including those recently introduced into general routine work. It is a pity, however, that the authors do not come down more strongly in favour of particular techniques; a large number is available and it is necessary to choose the most desirable in the given circumstances. Nevertheless, the book forms a handy reference book and guide to laboratory methods, which are succinctly described, and it is well suited for the use of laboratory technicians.

F. STRATTON

Semiconductor Surface Physics

Proceedings of the Conference on the Physics of Semiconductor Surfaces, held at Philadelphia, Pennsylvania, June 4–6, 1956. Edited by R. H. Kingston, with the assistance of E. Burstein, A. L. McWhorter, P. H. Miller, Jr., D. T. Stevenson, and P. B. Weisz. Pp. xvi+413. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1957.) 63*s*. net.

THE papers read at the Conference on the Physics of Semiconductor Surfaces have been divided, in the book, into four groups: (*a*) clean surfaces; (*b*) real surfaces; (*c*) adsorption and catalysis; (*d*) oxidation. The second group, not surprisingly, occupies as much space as the others put together; the third, mainly devoted to catalysis, is as much chemistry as it is physics.

It is only very recently that surfaces have been obtained sufficiently free of foreign atoms as to warrant the description 'clean', and further examination of their properties is necessary before existing theories can be checked. The real surfaces of germanium have long been studied, particularly in terms of rates of recombination of holes and electrons (or surface recombination velocity), surface conductances, contact potential and photo effects. Models of the surface, of both germanium and silicon, include 'fast' states, sited at the interface between an oxide layer and the bulk material and responsible for capture times of less than 1 μsec., and 'slow' states. The 'slow' states are probably sited on the surface of the oxide layer, have properties which are very dependent on surface treatment and the ambient atmosphere, have long capture times and are responsible for excess noise with an energy spectrum inversely proportional to frequency. The last of the four sections of the book is introduced by a summary of the oxidation of metals and includes a description of experiments on

the action of oxygen on clean germanium surfaces and a theoretical discussion. The outcome of some of the work described could be of overwhelming importance in improving the initial performance, the consistency and the reliability of transistors.

There are some gaps in the subject as presented, and some contrasts in presentation; but generally the book is very readable and is recommended to everyone studying the physics of semiconductors or the technology of transistors or semiconductor diodes.

J. R. Tillman

Quantitative Chemical Analysis

By Prof. Robert B. Fischer. Pp. xii+401. (Philadelphia and London: W. B. Saunders Company, 1956.) 38*s*. 6*d*.

THE author, a professor in the University of Indiana, is acutely aware that many a student whom he instructs in analysis will never use it in his career, and that those who become industrial chemists are more likely to meet a kind of analysis—instrumental—other than that learned at the university. Accordingly, Prof. R. Fischer has framed his course to meet this condition of things. His guiding principle seems to be to inculcate scientific thinking and so make the study and practice of analysis a training in research. Of the book's five parts the first consists of a well-planned and well-written introduction. Parts 2 and 3 deal with a selection of standard gravimetric and volumetric methods such as are usually found in first-year university courses. Part 4 is intended to be an introduction to instrumental analysis. It contains a description of optical and electric methods, but gives laboratory procedures for simple colorimetry and electrodeposition only. Part 5 consists of tables, including one of five-place logarithms. Ninety illustrations, including highly magnified electron micrographs of familiar precipitates, add to the interest of the subject-matter.

Throughout the book the treatment is thorough. Several of the chapters, such as the one on precipitation, and that dealing with analytical data, are, as it were, self-contained scholarly reviews of the subjects in question. Before any determination is undertaken the student is trained to seek out and study the fundamental chemistry involved, and to select the most appropriate techniques. Serious students mastering this book will get a good grounding in the theory and practice of quantitative analysis and will not find it a dull subject.

G. Fowles

Volumetric Analysis

By G. Fowles. Revised and enlarged edition. Pp. xiii+235. (London: G. Bell and Sons, Ltd., 1957.) 12*s*. 6*d*. net.

IN this edition the framework of the original text has not been altered, apart from the occasional rewriting of explanatory matter, such as that on *p*H and redox indicators. Two new chapters have been added, one on 'complexing processes' and the other on ceric sulphate as an oxidizing agent. In addition, forty-six numerical problems with answers have been added, together with a table of logarithms. The simple account of 'complexing processes' is very satisfactory, apart from the misleading statement that a bromide will not give a precipitate with the solution obtained by dissolving silver oxide in aqueous ammonia. Many teachers will welcome the clear exposition of Schwarzenbach's method for the determination of the hardness of water by the use of the sodium salt of ethylenediamine tetracetic acid—the name is much more frightening than the formula or the method of using it. The use of standard solutions of ceric sulphate is discussed and illustrated by a number of examples. As the author rightly points out, cerium is not a rare element, and ceric sulphate possesses many advantages over potassium permanganate as a reagent in volumetric analysis. The first edition of this book provided for an obvious need—it was reprinted five times—so that this volume with its useful additions should have a favourable reception.

A. C. Cavell

Thought, Life and Time as Reflected in Science and Poetry

By Dr. H. C. Wood. (Tenth Arthur Stanley Eddington Memorial Lecture, 19 February, 1957.) Pp. vi+58. (Cambridge: At the University Press, 1957.) 4*s*. 6*d*. net.

THIS, the tenth Eddington Memorial Lecture, is a worthy member of the series, and of note in that the author approaches his difficult task along the paths of history and theology. This route is, in the event, not so roundabout as it might appear. Eddington himself regarded natural science as a means of reaching one of the frontiers of human knowledge, beyond which other concepts, poetical, metaphysical or religious, had to take charge if the totality of our apprehension was to be achieved. One result of this was that Eddington wrote such beautiful prose (a lesson indeed to many a scientist) that occasionally he invited criticism for ambiguity. But the gain was greater than the loss: the æsthetic quality of his analysis was a direct challenge to the near-identity of truth and beauty.

For the rest, it seems unlikely that mankind has been vouchsafed something at least akin to a spark of the Divine if his desire to know ultimate truth is to remain for ever unsatisfied. We have yet to be convinced that a robot can be constructed to which it *matters* that, if it thinks, its thoughts are true.

Finally, the university must never lose or take lightly its emphasis upon intellectual imagination, and all that such a privilege implies. Following Eddington's footprints on the sands of time, it should be secure.

F. I. G. Rawlins

Seven Pond Creatures. Seven Birds. Seven Trees. Seven Animals

15 pp. each. By Edna Johnson. (Oxford: Basil Blackwell, 1957.) 2*s*. each.

MANY writers have attempted to deepen the interest of young children in living creatures. In a well-known series Enid Blyton used her imaginative gifts to prepare delightful fairy-like stories based on authenticated fact; the series was wholly successful. Other writers have prepared factually accurate accounts which have been less successful because they took insufficient note of the romantic quality of the child-mind. In this series Edna Johnson uses brightly coloured illustrations by Anyon Cook to attract attention and then adds to the interest by text which has been meticulously prepared and which has all the appeal of simple blank verse. It should commend itself to most young children. The text is precise, accurate, sparing of words and supplemented both by homely black-and-white drawings and by photographs from well-known bird photographers. The drawings are worthy of the coloured illustrations and the text; some of the photographs are badly reproduced and do not add to attraction or understanding.

THE LARGE-SCALE STRUCTURE OF THE GALAXY

By F. J. KERR, J. V. HINDMAN and MARTHA STAHR CARPENTER*

Commonwealth Scientific and Industrial Research Organization, Radiophysics Laboratory, Sydney, Australia

OPTICAL studies of the structure of our galaxy are restricted to the immediate neighbourhood of the Sun, because the light from distant stars in the galactic disk is heavily attenuated by interstellar dust. Radio waves, on the other hand, can penetrate the dust, and the whole of the galaxy is accessible to radio investigations, provided the wave-length is not too long.

The most powerful of the radio methods for studying large-scale galactic structure is based on observations of the line from interstellar hydrogen at a wave-length of 21 cm. In this case the possibility of measuring radial velocities provides a means of distinguishing, to a large extent, between radiation from sources at different distances along the same line of sight. In these observations, the hydrogen is used as a tracer, to delineate the spiral arms and the thin galactic disk in which the gas is largely concentrated. The spiral pattern for the northern part of the Milky Way, as derived from hydrogen line observations by the Leyden Observatory group, is now well known[1], but only a few preliminary results have so far been published for the southern part[2].

In this communication we extend the spiral picture, through the addition of more comprehensive southern observations. We also present a 'relief map' of the galaxy, which shows the major departures of the hydrogen layer from a plane, and briefly discuss the overall distribution of the hydrogen.

The southern survey has been carried out with an aerial of diameter 36 ft. (beam-width 1·5°), and a receiver band-width of 40 kc./s. (equivalent to a velocity spread of 8·5 km./sec.). A strip of sky around the Milky Way, about 8° wide in galactic latitude, has been covered in a series of sweeps, usually 5° apart in longitude. The southern half of the Milky Way has received the main attention, but some observations have also been made in the northern longitudes which are visible from Sydney. A fixed-frequency stationary-aerial system has been used, allowing the Milky Way to drift across through the aerial beam. Simultaneous observations were made on four separate receiving channels.

The analysis is now sufficiently advanced to show the main structure and shape of the galaxy quite clearly, although some parts of the observational material have still to be reduced. No allowance has yet been made for the finite resolving power of the instrument, or the random motions of the interstellar gas clouds, but the broad conclusions presented here should not be significantly changed. The detailed results of the study will be published later.

Spiral Structure

A composite picture of the spiral pattern in the galactic disk is given in Fig. 1, with the new Sydney results to the left, and the latest spiral diagram from Leyden[3] to the right.

The individual observational points are shown for the Sydney diagram only. The positions of the various concentrations of hydrogen which can be seen in each line of sight are indicated by filled circles; these are associated with the various peaks on each line profile. A series of small open circles corresponds to a broad peak on a profile, which

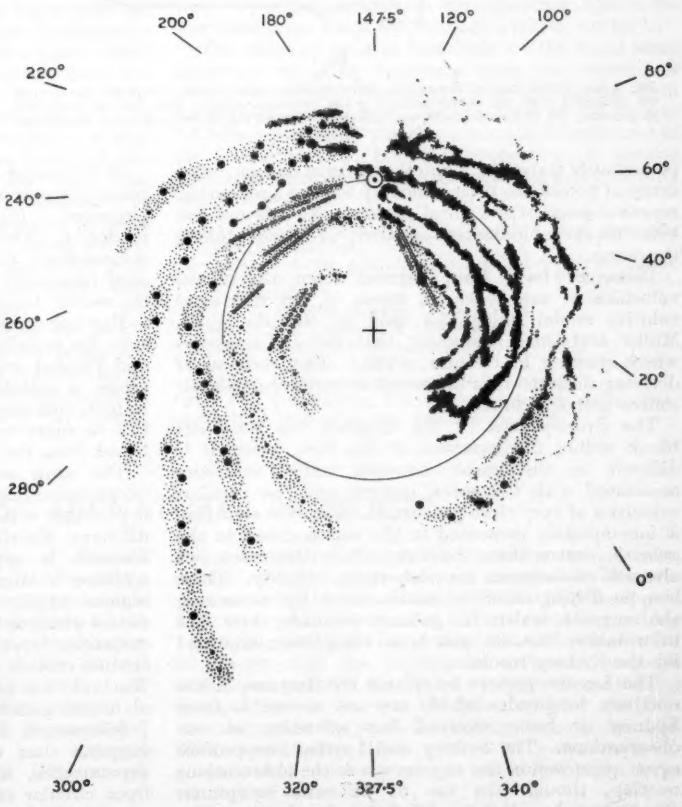

Fig. 1. Composite spiral diagram of the galaxy. The Sydney pattern is to the left of the picture, the Leyden one (slightly retouched) to the right, with some overlap. The different character of the two sides results from different methods of analysis and representation. The distance from the Sun (⊙) to the galactic centre (+) is taken as 8·2 kiloparsecs.

* Now returned to Cornell University, Ithaca, N.Y.

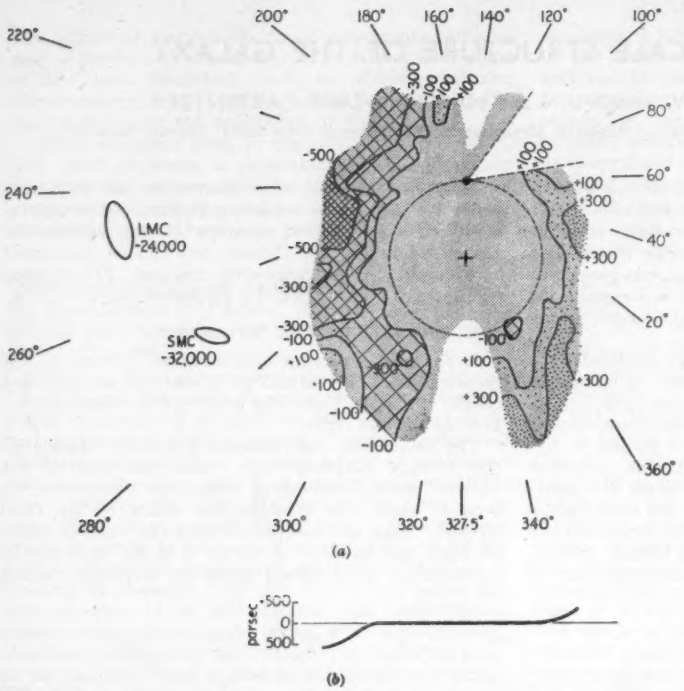

Fig. 2 (*a*) Relief map of the galaxy, showing departures of the equatorial surface of the hydrogen from an approximation to the 'principal plane'. The contour levels are in parsecs. (*b*) Cross-section through galactic centre, in the direction of Large Magellanic Cloud

presumably indicates a spiral arm seen end-on. The array of points has been joined up to give a schematic representation of the spiral pattern. No attempt has been made to indicate variations of density along the arms.

Distances have been derived from the radial velocities of the peaks, in terms of the rotational velocity model which was used by van de Hulst, Muller and Oort[1], assuming that the gas is everywhere moving in circular orbits. This method of deriving distance fails in sectors towards the galactic centre and anticentre.

The Sydney part of the diagram has been left blank within 2 kiloparsecs of the Sun, where it is difficult to distinguish between radial velocities associated with the spiral pattern and the peculiar velocities of very close gas clouds. Also, the structure is incompletely presented in the region closer to the galactic centre than the Sun, where there are two alternative distances for each radial velocity. These can be distinguished to some extent by measuring the angular width in galactic latitude, but this information has not yet been completely analysed for the Sydney results.

The Leyden picture completes the diagram in the northern longitudes which are not accessible from Sydney or have received less attention in our observations. The Sydney and Leyden line profiles agree quite well in the regions where the observations overlap, though the use of different equipment parameters has led to differences in detail. The agreement in the positions of the spiral arms is less good, because the two sets of results have been worked out with slightly different velocity models. In view of the fluid state of such models at present, it was thought unnecessary to bring the two parts to the same basis, by recomputing one or other of them.

The different appearance of the two parts of the diagram results from the different approaches which have been used. The Sydney diagram is a schematic representation, and is based only on the well-defined features of the line profiles. The Leyden picture, on the other hand, is an 'artist's impression', following the contours of highest gas density, and it has also taken account of the finer and less-certain details of the profiles.

Our own observations do suggest, however, that there are significant differences in the hydrogen distribution on the two sides of the galaxy. In the outer regions, the peaks in the spiral arms are less pronounced on the southern side than they are in the northern sector. This implies that the gas is less well organized into spiral arms in southern longitudes, with something of a continuum of gas between the arms. Also the wings of the profiles (on the side corresponding to the outer regions of the galaxy) extend much farther out in southern longitudes.

Three major conclusions can be drawn from this spiral diagram: (i) The galaxy has a multi-armed structure. (ii) The arms show a general trailing tendency. (The direction of rotation in this diagram is clockwise.) (iii) There are shortcomings in currently used rotational velocity models. (This follows from the rather 'heliocentric' form of the derived pattern.)

Reading outwards from the centre on the southern side, the so-called Scutum-Norma[4], Sagittarius, Orion and Perseus arms can each be followed over a wide range of galactic longitude. There are suggestions, in fact, that the major arms can be followed through two or more revolutions, but this cannot be established from the present results.

The arms seem to be clearly trailing, but the exaggerated degree of trail near longitudes 300°–320° is probably a result of the model which was used. A different distribution of rotational velocity with distance is apparently needed; but there is in addition a large quantity of gas in this and other regions which cannot be fitted to any reasonable model which is limited to circular orbits. There is no evidence, however, for a general deviation from circular motion of the type suggested by Edmondson[5]. The velocity pattern is found to be asymmetrical about the galactic centre, in the region between 3 and 7 kiloparsecs from the centre, but the evidence suggests that this is due primarily to structural asymmetries, rather than to wholesale departures from circular motion.

The Galactic Plane and its Distortion

We consider now the disposition of the gas in a direction normal to the galactic plane. Each sweep

across the plane at a given longitude and frequency gives the 'vertical' distribution of the neutral hydrogen at a particular place in the galaxy. In particular, the galactic latitude at which peak brightness occurs gives a point on the 'equatorial surface' of the layer of neutral hydrogen.

Thus we can delineate a section through the galaxy for each line of sight; the observations give the variation of galactic latitude with radial velocity, from which we can derive a curve showing the height of the equatorial surface as a function of the distance.

The hydrogen is confined to a thin layer (about 250 parsecs between half-density points) in the galactic disk, and observations of this type provide the best method for a new determination of the galactic plane, the position of which is under review by the International Astronomical Union.

A relief map of the galaxy, built up from the Sydney observations, is shown in Fig. 2*a*. This picture is based on the same velocity model as the spiral diagram, and again it has been drawn without making allowance for random motions; but the main features should not be changed by later modifications.

The gas layer is found to be remarkably flat in the inner parts of the galaxy. We have called the mean plane in this region the 'principal plane of the galaxy'. (This plane does not necessarily pass through the Sun.) For the present purpose, we have used an approximation to the principal plane as the reference level in Fig. 2. This approximation is a plane which contains the Sun, and slopes downwards from the conventional 'galactic plane' at an angle of 1·5° towards the galactic centre at longitude 327·5°.

In the outer regions, the gas layer shows a systematic distortion, with a twist downwards on the left of the picture and upwards on the right. The effect can be seen more clearly in the cross-section of the galaxy given in Fig. 2*b*. The distortion appears to be a large-scale property of the galaxy, as the height of the gas layer varies fairly regularly, with little relationship to the pattern of spiral arms. This effect has also been noticed by Burke[6].

The downward deviation is greatest in the region nearest the Magellanic Clouds, which are below the plane in the position indicated; the upward deviation is greatest on the opposite side. The phenomenon suggests a gravitational tide produced by the Clouds, but the effect appears to be about two orders of magnitude too large for a simple gravitational explanation. There may be an analogy with cases reported by Zwicky[7] and others, which imply unexpectedly large interactions between galaxies.

The interpretation is less clear in the far wing of the line profile, beyond the region of the spiral arm peaks, where the intensity is very low. Here there is often a reversal in the curve of galactic latitude against radial velocity, from which the relation between height and distance is derived. This might be taken to indicate that the deviation of the equatorial surface from the principal plane decreases again beyond the region shown in the diagram. However, the reversal is associated with an increase in the angular width, and sometimes occurs at velocities which are too great to be fitted to a circular orbit model. Our interpretation is that the radiating gas in this case is relatively close to the Sun, and moving in non-circular orbits.

As well as giving the shape of the hydrogen concentrations, these observations can provide the point-by-point density distribution of neutral hydrogen throughout the galaxy. The detailed distribution has not yet been fully worked out for the southern observations, but we have derived provisional results for the overall amount of neutral hydrogen in the galactic disk, and its mean radial distribution[8]. These have been compared with corresponding figures for the total mass given by Schmidt's recent model[9].

The ratio of neutral hydrogen to the total mass increases on going outwards from the centre; it rises from a very low value in the nucleus to about 15 per cent at the Sun's distance, and 50 per cent at 14 kiloparsecs out. The gas is a major constituent in the outer regions, but the proportion of neutral hydrogen integrated over the whole galaxy is only about 2 per cent.

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BIOGENESIS OF NATURAL PRODUCTS

A SYMPOSIUM on "Biogenesis of Natural Products", arranged by Section B (Chemistry) of the British Association and held on September 6 in Dublin, was introduced by the president of the Section, Dr. J. W. Cook, who began by remarking on the appropriateness of the choice of Sir Robert Robinson as chairman. He recalled that Prof. J. N. Collie, of University College, London, himself a pioneer in the field, when introducing his successor, Prof. Robinson, remarked that his sort of chemistry was 'real' organic chemistry. This remark is even more recognizably true to-day.

Sir Robert opened his consideration of "Biogenesis of Structural Relations: the Organic Chemist's Contribution" by pointing out how organic chemists' interests in natural products have changed from being an interest purely in structures to one concerned with the origins of such structures. His own pioneer work in the alkaloid field in 1917 indicated that structural relations do, in fact, reveal something of origins, although he realized that the final word is always with the biochemist. Recent powerful techniques such as the use of compounds containing isotopic carbon (carbon-14) have enabled the biochemist to test the predictions of the organic chemists. Their speculations have proved in some cases incorrect, but were correct in a surprisingly large number of cases.

He considered briefly the origins of fatty acids with an *even* number of carbon atoms from acetic acid units (containing two carbon atoms) and some of the other distinguishable biogenetic groups: the

*iso*pentane compounds (terpenes, steroids), the C_6—C_3—C_6 groups and others.

Sir Robert's main thesis concerned the structural relations of alkaloids. The parallel series of pyrrolidine (five-membered ring) alkaloids, derived from the amino-acid ornithine, and the piperidine (six-membered ring) alkaloids derived from the amino-acid lysine containing an extra carbon atom, had originally led to biogenetic theories since confirmed by tracer studies. The whole series of compounds of the *iso*quinoline series can be correlated on the basis of biogenesis from phenylalanine and condensation with an aldehyde, followed by secondary reactions of methylation and oxidation. An attempt to do this in the laboratory in one case led to an alkaloid, then unknown, but discovered many years later in a Queensland tree. Adding a further carbon atom to the *iso*quinolines formed from two phenylalanine units leads to the berberine group, and hence by rearrangement to the sanguinarine group. Even morphine and related alkaloids, despite superficial appearances, can be derived (hypothetically so far) by chemically probable ring-closures in this series. Such considerations have led to a revision of the original formulæ of both berberine and morphine.

A similar series of alkaloids can be distinguished based on tryptophan instead of phenylalanine. Harmine is a strict analogue; others, such as strychnine, cinchonamine, quinamine and cinchonine, can all be related to a '*para*' berberine type on the basis of a ring-fission postulated by R. B. Woodward. Thus, strychnine and quinine, despite enormous superficial differences, are biogenetically closely related. These ideas have again been fruitful in leading to correct structures for emetine and ajmaline.

Sir Robert said that Nature is very clever; but listening to his survey gave the impression that some chemists at least are not far behind.

Prof. A. J. Birch (Manchester) discussed the use of isotopically labelled compounds—mainly 1-^{14}C-acetic acid, ^{14}C-formic acid and $^{14}CH_3$-methionine—for testing hypotheses based on structural analogies, using moulds as the experimental media. Moulds were chosen because of their ease of growth, the ease of obtaining incorporations, the variety and high yields of some of the compounds produced and their intrinsic interest as antibiotics and antifungal agents. A postulated biosynthesis of griseofulvin by head-to-tail linkage of seven acetic acid units, and appropriate cyclizations, has been confirmed by reference to the degradations of the isotopically labelled substance derived from $CH_3{}^{14}CO_2H$. It was shown that, in some cases at least, C-methylation can occur from methionine or formic acid in the same way as can O-, S- or N-methylation. Among the substances being investigated are terramycin and methymycin. Extensions to terpene biosynthesis were mentioned, and it was shown that $HOCH_2CH_2C(OH)(CH_3)CH_2CO_2H$ (mevalonic acid) is an irreversible intermediate in producing the terpene chains of mycophenolic acid and mycelianamide. Prof. Birch pointed out that the results obtained can be extrapolated to many products from higher plants, notably flavonoids and anthocyanins.

Prof. T. S. Wheeler (University College, Dublin) was not sure whether to serve a vegetarian diet for non-scientists or a meat diet for his colleagues; but he succeeded in producing a tasty well-balanced dish. He gave a summary of the chemical types related to the flavones and flavanones which occur throughout higher plants. He pointed out that the C_6—C_3—C_6 classification of Robinson is of fundamental importance. This turns out to be based probably on a C_6—C_3-unit with a 3 : 4-hydroxylation pattern (derived from shikimic acid) and a C_6-unit (derived from acetic acid) with a 1 : 3 : 5-hydroxylation pattern (giving 5 : 7-hydroxyls in the resulting flavonoid pigment). He turned to consider the supporting evidence for these ideas, obtained by tracer experiments by Geissman and Neish and their collaborators on the biogenesis of quercetin in buckwheat. This work clearly establishes the sequence: shikimic acid → prephenic acid → *p*-coumaric acid + 3 (acetic acid) → a C_6—C_3—C_6 precursor.

Prof. Wheeler emphasized that many of the principles of chemical stability deduced in the laboratory clearly hold also in the biochemical world, and cited the equilibrium between chalcones and flavanones. The presence of a 5-hydroxyl group in the latter stabilizes them by hydrogen-bonding; similarly, a 2′ : 6′-dihydroxy flavanone can become isomerized (via the chalcone) to a more stable 2′ : 5-dihydroxy flavanone. This may account for the lack of occurrence of the latter type in Nature.

Prof. T. R. Seshadri (Delhi) put forward views on the part played by C_6-units in natural products, particularly those found in lichens and in moulds. The typical C_6-unit is that of orsellinic acid (2 : 4-dihydroxy-6-methylbenzoic acid), which enters into many depsides, and by secondary oxidation processes into depsidones. Some C_6-units have an extra carbon atom, which may be CH_3, CH_2OH or CHO, in the 3-position, known to be a chemically active position. The presumption is that it is introduced. Prof. Seshadri considers that the most fundamental unit can be represented as 2 : 4-dihydroxy-6(hydroxymethyl) benzaldehyde, which can undergo various oxidations, reduction and condensation reactions leading to known depsides, depsidones, benzoquinones, anthraquinones and xanthones. He suggested that in some cases hydroxyl groups may have been reduced directly from the phenolic ring, and cited in support the reduction of the monotosylate of orsellinic acid with Raney nickel to obtain a good yield of 6-methyl salicylic acid. Further natural products, including stilbenes, tropolones and compounds related to gladiolic acid, can be produced by variants of the scheme. In the opinion of the present writer, this hypothesis amounts to a partial restatement of the acetic acid theory and its ancillary theory of the introduction of C_1-units, at a less-fundamental level, and is less satisfactory for a general correlation of the compounds. It also appears likely that mould tropolones arise from shikimic acid.

Dr. G. J. Popjak (Medical Research Council Radiopathology Research Unit, London) apologized quite unnecessarily for intruding on a gathering mainly of organic chemists, and explained that some fifteen years ago he had felt compelled to abandon his purely medical approach to atherosclerosis to find out something about the biochemical causes of it, notably the mechanisms of the biosynthesis of cholesterol. In the sequel it seems highly probable that the approach which he helped to pioneer is in fact the only logical one in attempting to cope with the disease. He explained that much of the chemistry was the result of his close collaboration with Dr. J. W. Cornforth. He discussed the earlier isotope work of Bloch and Rittenberg, which showed that acetic acid contributes the twenty-seven carbon

atoms of cholesterol (fifteen from CH_3, twelve from CO_2H). An amicable division of the field between the American and British groups has now led to an elucidation of the sources of all the individual carbon atoms in cholesterol (that is, whether from CH_3 or CO_2H). This result, taken in conjunction with a much earlier hypothesis of Robinson that the acyclic triterpene squalene folds, with loss of three carbon atoms, into cholesterol, has permitted the elucidation of the major stages in the biosynthesis. A further great contribution has recently been made by Dr. K. Folkers and his group at Merck and Co., who have shown that the biochemical origin of the isopene unit is mevalonic acid ($HOCH_2CH_2C(OH)(CH_3)CH_2CO_2H$), which loses its carboxyl group in the process of incorporation. The overall process seems to be: acetic acid → *X* → mevalonic acid → *Y* → squalene → lanosterol (a 4 : 4 : 14-trimethyl steroid) → a 4 : 4-dimethyl steroid → zymosterol (a C_{27}-steroid with 8 : 14- and 24-double bonds) → desmosterol (5- and 24-double bonds) → cholesterol (5-double bond). The natures of some of the intermediates, notably *X* and *Y*, and the exact mechanisms of some of the processes are still not at all clear.

The general impression left by the symposium was of rapid advance and a new air of certainty replacing somewhat misty speculations. However, it is clear that a pencil and paper are still very useful tools to produce useful and fruitful suggestions, if not proofs. Little time was left for discussion, and Sir Robert Robinson regretfully closed the symposium after thanking the speakers. A. J. Birch

CONSTITUTION AND CARE OF THE INFANT ANIMAL

Sections I (Physiology and Biochemistry) and M (Agriculture) of the British Association held a joint session during the recent meeting at Dublin on the subject of the infant animal. Prof. R. A. McCance opened the meeting with a general paper on "The Physiology of the Newborn Animal". He began by pointing out what a tremendous physiological upheaval birth must be, and then alluded briefly to the difficulty of finding one's way through the perplexing maze of species and developmental differences to the great general principles of infant physiology. He proposed, nevertheless, to try to do so, and began by saying a few words about the large volume of fluid outside the cells of all newborn animals. There may be some association, he suggested, between this and the anabolic impulse so characteristic of the fœtus and newborn. Further expansion of the extracellular fluids by experimental means has in his experience materially reduced the catabolism of tissue protein. He then dealt with the ways and means by which the newborn animal is prepared by Nature to withstand the infections to which it is inevitably exposed the moment it leaves the sheltered world *in utero*. He traced out the path by which the macromolecules of γ-globulins and other proteins reach the plasma of the developing organism in the various species, and directed attention to some of the effects of this protein transfer, apart altogether from the establishment of passive immunity. He spent the rest of his time in discussing aspects of homœostasis. He showed, for example, how unstable the body temperature can be in the newborn period, and referred to some of the factors responsible for its maintenance. He took as his examples the poikilothermic newborn rat, the piglet and the human infant, and compared and contrasted them. He then went on to deal with the response to a lack of oxygen, and began by referring to the excellent work which has been done on the subjects of cold and anoxæmia by the great pioneers, such as Harvey, Boyle and particularly Edwards. He made the point that, although there are great species differences, all newborn animals are very tolerant of anoxia. This is due, he believes, to the ability of the newborn animal to utilize anaerobic glycolysis to maintain the structure and function of its essential organs, particularly of its brain. The survival time in nitrogen is largely conditioned by the state of development of this organ, but any study confined to the survival-time tells one nothing about the complex respiratory and cardiovascular changes induced by a lack of oxygen in the first and final days of life. Anaerobic metabolism, he pointed out, utilizes the resources of the body wastefully and leads to the production of potentially dangerous end-products. It also produces less heat. This tends to reduce body temperature, which slows down metabolism all over the body, mitigates to some extent the dangers of the wasteful anaerobic glycolysis, and is an important element in prolonging the lives of anoxic newborn animals, including, in all probability, man. If this is so, resuscitation of the cold blue infant should begin with glucose to provide fuel for glycolysis and oxidation, pass on to re-oxygenation and be followed by warmth only when oxygenation has become effective.

Prof. McCance then passed on to the subject of food, growth and renal function. This last is generally reckoned to be poor by adult standards in the newborn period, yet the concentration of urea in the serum is normal at birth and remains so. Few have seen the extent or significance of this paradox, but investigations carried out at Cambridge have explained it. The power of growth, it would appear, may be far more important than the operation of the kidney in maintaining the concentration of urea in the body fluids within normal limits. 90 per cent of the protein nitrogen in the diet of a rapidly growing animal may be utilized for the synthesis of tissue protein and only 10 per cent of it appear as urea and other end-products to be excreted by the kidney.

The weakness and helplessness of the infant have been a constant theme with philosophers. Helpless it may be in that it cannot stage its own come-back from an abnormal situation—it has to be brought back. But many of the signs of weakness are really marks of strength, if by strength is meant the ability to survive. The secret of handling and caring for the newborn is to make the most use of the strength with which it has been endowed by Nature, and if its stability has been upset, to restore this physiologically and not in some haphazard way which may seem the obvious one at first sight.

The next two speakers dealt with more specialized branches of the subject. Mr. G. A. Lodge, of the Rowett Research Institute, read a factual paper on

the nutrition of the young pig. He dealt first with the composition of sow's milk and the quantity secreted at different stages of lactation. The concentration of protein is high in colostrum, associated perhaps with the presence of antibodies; it falls as full milk is established, and thereafter tends to rise, while that of fat and lactose falls. The calcium–phosphorus ratio changes from about 1 : 2 in colostrum to 1 : 0·6 in normal milk.

A piglet left with the sow takes about 1·5 lb. of liquid milk a day during the first week, 2·4 lb. a day during the third to fifth weeks, then consumption drops to 1·7 lb. a day during the eighth week. About 0·8 lb. of dry milk-solids is required to produce each pound of increase in body-weight.

For commercial reasons it is desirable to wean piglets as early as possible, so as to free the sow for the next litter. Weaning at birth has been successful only under laboratory conditions; and since piglets get all their antibodies through the colostrum, elaborate precautions against infection are necessary if they are to be reared without it. From two days of age piglets can be reared on artificial food. They require liquid food at first, and they are unable to digest starch or sucrose or any protein other than casein for the first week or so. From ten days onwards dry meal diets are generally employed. The optimum amount of fat seems to be about 8 per cent, and of protein 25 per cent, decreasing to 18 per cent after the piglet has reached a weight of 25 lb. Piglets ten days old are able to digest starch and all the sugars, though their ability to utilize lactose declines after about three weeks.

The third paper of the meeting, entitled "The Nutrition of the Early Weaned Calf", was given by Dr. J. H. B. Roy, of the National Institute for Research in Dairying. Dr. Roy explained that by weaning he meant removal of the calf from its mother at an early age, rather than changing its diet from liquid to dry food. For centuries the dairy calf has been weaned soon after birth because of the demand for liquid milk for human consumption. The newborn calf, like the adult ruminant, has four stomachs, but only the fourth stomach, or abomasum, is functional, for milk by-passes the rumen and reticulum.

The calf receives all its antibodies through the colostrum. All calves should be given colostrum for the first 24 hr., and preferably for four days after birth if deaths from *E. coli* infections are to be prevented. Certain antibiotics, in particular the tetracyclines, will give protection against these conditions. Calves are normally fed on whole milk for the first three weeks, and thereafter on milk substitutes. Milk substitutes do not give such satisfactory results when fed directly after the colostrum period. The pre-ruminant calf seems to be unable to utilize any carbohydrate other than lactose or glucose, and it cannot tolerate more than 250 gm. of sugar a day. Carbohydrates, therefore, cannot provide the main source of energy in milk substitutes during the early post-natal period; and moreover, a certain amount of fat seems to be essential for the young calf, and, of the milk by-products, probably only buttermilk contains enough of this. If fat is added to reconstituted dried skimmed milk, it must be properly emulsified and homogenized or it will cause diarrhœa. The digestibility of fat by piglets, young guinea pigs and pups has been shown to depend upon the chain-length of the constituent fatty acids rather than on their saturation. The shorter the chain of saturation the greater the digestibility.

This is probably true for the young calf, although the use of fats containing highly unsaturated fatty acids has also been detrimental to the health of young calves.

No suitable substitute for milk protein in the diet of the pre-ruminant calf has yet been found, and even spray-dried skimmed milk which has been processed with a high pre-heating temperature may be of less value than fresh skimmed milk or milk processed at a lower temperature. This effect may be due to the denaturation of the soluble protein by the heat treatment, or to the fact that such milks do not clot with rennet.

The age at which the calf turns over to the ruminant method of digestion depends upon the diet which it has received. The longer it has access to a plentiful supply of milk, the less it will want to eat the fibrous and starchy foods necessary for the functional development of the rumen. It is a great advantage to the farmer to induce his calf to become a ruminant as early as possible, for once the rumen begins to function cheap foods can be used, and there is no longer the same risk of diarrhœa. The ingestion of roughage stretches the walls of the reticulo-rumen and increases their capacity. The rumen papillæ, however, are stimulated by readily absorbable material, not by fibrous foods.

Dr. Roy next turned to the microbial flora of the gut. The abomasum of the young calf supports a large and diverse population of lactobacilli. The typical rumen amylolytic streptococci and protozoa of the adult animal do not become properly established until the rumen *p*H is stabilized at about neutrality, which does not normally happen until the calf is nearly eight weeks old. The establishment of the rumen microbial flora can be encouraged at an earlier age if the calf can be induced to eat dry food. Grass is by far the cheapest dry food for the young calf, but unfortunately most calves in Britain are born during the winter months when grass is not available in any quantity. With other dry foods most consistently good results have been obtained with weaning at eight weeks, although recently abrupt weaning at three weeks of age has been shown to give satisfactory growth-rates.

In the discussion which followed, Dr. D. P. Cuthbertson asked Dr. Roy whether he believed it better to transfer a calf abruptly or slowly to a ruminant type of diet. Dr. Roy favoured transferring it slowly.

Dr. Magee raised the question of piglet anæmia, which had not been mentioned by Dr. Lodge. A single injection of iron intramuscularly had been found very effective for piglets, and also in certain circumstances for calves. Dr. Roy agreed that if iron is given to calves it raises their hæmoglobin-level, but he pointed out that calves do not generally show clinical signs of anæmia as piglets do, presumably because they grow more slowly.

Mr. D'Arcy asked if anyone knew why feeding freshly harvested barley or rye to pigs has such disastrous effects. His own experience covered two prize sows which had had such severe diarrhœa in consequence that they died within two days. Other speakers said that they had heard about this phenomenon, but no one was able to tell the meeting what the toxic factor, if any, could be.

E. M. Widdowson

PHYSIOLOGICAL EXPEDITION TO THE ANTARCTIC

By Dr. L. G. C. E. PUGH
Medical Research Council Laboratories, Hampstead, London, N.W.3

AN Anglo-American Physiological Expedition will be leaving shortly for the Antarctic to carry out studies connected with human acclimatization to cold. The party will assemble in California at the end of November and travel from there via New Zealand to Ross Island at the edge of the Antarctic Continent. They will be taking part in Operation Deep Freeze II of the International Geophysical Year.

The party is being transported by air under arrangements made by the Office of Naval Research, U.S. Navy, and by the United States Military Air Transport. In this way the team hopes to accomplish a programme in four months, which would otherwise require wintering in the Antarctic and four months travelling.

In spite of common experience that one grows accustomed to cold, as well as anthropological testimony, very little objective evidence in support of cold acclimatization has so far been found. Studies have hitherto been hampered by lack of methods for measuring metabolism and changes in body temperature continuously over periods of days at a time.

Major J. M. Adam, R.A.M.C., and the author, whose participation has been made possible by a generous grant from the Wellcome Trust, will be carrying out studies of this nature on themselves and on members of other expeditions already in the Antarctic. They will use apparatus developed by Mr. H. S. Wolff at the Medical Research Council's Division of Human Physiology at Hampstead, which will enable them to obtain prolonged records of the kind required. Samples of blood plasma will also be collected for lipid analysis.

It is well known that the fatty composition of the blood and tissue lipids of hibernating animals during winter is different from that during summer. The differences are such that the degree of unsaturation of the fatty acids of the lipids is higher, and the melting point lower, in winter than in summer. A preliminary investigation of the blood lipids of persons exposed to intense cold during the British North Greenland Expedition was carried out by Dr. J. E. Lovelock, of the National Institute for Medical Research, Mill Hill. The results suggested that similar changes to those found with hibernating animals may occur in the blood lipids of human beings. Dr. Lovelock will continue his studies on the samples of blood plasma brought back from the Antarctic.

A further reason for interest in the problem of blood lipids is the finding that the fatty-acid composition of the plasma lipids of patients with coronary artery disease has shown differences between them and normal subjects similar to those observed in the winter on the Greenland expedition. This similarity could imply that the regional and social differences in the incidence of coronary artery disease may be as much a consequence of environment as of diet.

The American members of the expedition, led by Dr. Nello Pace, of the University of California, are interested primarily in physiological reactions to stress. The pattern of adrenal cortical response to varying stresses has already been studied by this group on front-line combatants in the Korean War as well as in other stress situations. Surgeon-Commander Miller, of the United States Navy, will be studying the epidemiology of upper respiratory infections among personnel in the Antarctic bases on Ross Island. Antarctic personnel are said to remain almost entirely free of colds, except following the arrival of ships or on opening packing cases and mail. In ordinary communities this mode of infection, namely by contact with contaminated objects, is thought to be unusual, at least as regards the common cold virus.

Some of the expedition's equipment was recently on view at the Medical Research Council's Laboratories at Hampstead. It included sledging rations incorporating a variety of new dehydrated meats and other foods, packaged entirely in plastic bags, thus avoiding the use of tins. The cooking equipment employs propane in place of paraffin, and is claimed to give nearly 80 per cent heating efficiency compared with 40 per cent for the conventional paraffin stoves used previously. Also on view were newly designed sledges and various types of protective clothing and other equipment. It was pointed out that this expedition could afford to be more experimental in its approach to problems of equipment than other expeditions, because it will not be called on to move more than two hundred miles from a well-equipped base.

OBITUARIES

Prof. G. H. Wooldridge

GEORGE HENRY WOOLDRIDGE, emeritus professor of veterinary medicine and the doyen of the Royal Veterinary College, died on August 30 following an operation; he was eighty years of age. For some years a gradual failure of his eyesight had caused him to retire from active participation in the work of the many bodies and societies which he had served so well for many years, and to relinquish his consultation practice in which his services had been in great demand. Mentally and physically he remained in good health, and the illness which caused his death was of a relatively short duration.

He was born at Stoke-on-Trent and was very proud to be a Staffordshire man. He was educated at St. Peter's School at Stoke and at Orme Boys' School, Newcastle-under-Lyme. After serving as junior assistant at E.M. School at Newcastle-under-Lyme (1892–93) he decided to enter the veterinary profession. As was the custom in those days, he was placed as pupil with J. Wilson, of Nantwich, in 1893, before entering the Royal Veterinary College in 1895.

He graduated M.R.C.V.S. in July 1899, gaining first-class honours in the final examination, and he obtained the fellowship of the College in December 1905.

Wooldridge's undergraduate career was one of exceptional merit. He was medallist in biology, chemistry, anatomy, surgery and medicine, and he also won the coveted Coleman Prize and Centenary Medal. After graduation he served for a year as tutor at the Royal Veterinary College. In 1900 he went to the Royal Agricultural College at Cirencester as professor of veterinary science and bacteriology. In 1903 he was appointed professor of veterinary medicine in the Royal Veterinary College of Ireland. He returned to Camden Town in 1908, becoming professor of materia medica and therapeutics in the Royal Veterinary College and with charge of the out-patients department. In 1912 he was translated to the senior post in the Department of Medicine and continued in that chair until his retirement in 1943. He became vice-principal of the College in 1936, and on his retirement he was honoured by being elected emeritus professor of veterinary medicine.

His professional life was in the academic sphere, but he took a great and active interest in all matters appertaining to veterinary science. He served as president of the Central Veterinary Society, the National Veterinary Medical Association (now called the British Veterinary Association), the Royal College of Veterinary Surgeons and the Comparative Medicine Section of the Royal Society of Medicine. He was a vice-president of the Research Defence Society. He served on the council of the Royal Sanitary Institute, where his interest in the hygienic production of food products of animal origin had full scope. He was also honorary veterinary surgeon to the Zoological Society of London for many years. He acted as examiner in medicine, hygiene and meat inspection for several academic and professional bodies. He was joint editor of the *Veterinary Journal* during 1906–14 and he contributed many papers to veterinary literature. In this manner his magnum opus was the two-volume "Encyclopædia of Veterinary Medicine". Many sections of this work came from his own pen.

Wooldridge enjoyed teaching and his contact with students. He entered vigorously into every sphere of college life—sporting, social and academic. He was honoured by his profession on many occasions. The Royal College of Veterinary Surgeons gave him the greatest honour within its power, the Steele Memorial Medal, and the Central Veterinary Society did likewise by the award of its Victory Medal and honorary fellowship. One of the greatest interests of his life and also of Mrs. Wooldridge, his helpmate for fifty years, was their work for the Victoria Veterinary Benevolent Fund. Many who have fallen on bad times have had cause to thank this kindly man and his gentle wife.

J. McCunn

Mr. Leo Bagrow

Leo Bagrow, who died at The Hague on August 9 at the age of seventy-six, was a commanding figure among students of the history of cartography. A scholar with fire in his belly, he possessed outstanding qualities of enthusiasm, determination and thoroughness. These enabled him to pursue his chosen subject continuously for more than half a century and in spite of interruptions caused by the two major political convulsions of our time, in which he was unwillingly involved.

After completing his education in St. Petersburg, Bagrow served, before and during the First World War, in the Russian Imperial Navy, mainly as a hydrographer. Surveys in the Caspian Sea and Gulf of Finland were followed by expeditions to various parts of Siberia and to Kamchatka and by visits to Japan. He was already an ardent collector of early maps, particularly of Asiatic Russia and the Far East, and his first studies were published between 1912 and 1917.

After the Revolution, Bagrow and his wife emigrated in November 1918 to Berlin. Between the wars, missions for commercial firms gave him ample opportunities to continue his search for early maps; he travelled throughout Europe and in Asia, Africa and North America. An extensive knowledge of European libraries is revealed in his invaluable bio-bibliographical studies of sixteenth-century cartographers ("A. Ortelii catalogus cartographorum", 1928–30). In 1935 he founded "Imago Mundi: a Review of Early Cartography"; this annual, of which Nos. 1–3 had appeared by 1939, has provided a vehicle for much of the best work in this field by Bagrow and others. At the same time he initiated a series of facsimiles of early maps entitled "Anecdota Cartographica".

In 1945 a Swedish aircraft carried Bagrow, his wife and their tame sparrow from Berlin to Stockholm, where with stubborn courage he resumed his scientific activity in spite of increasing deafness and the loss of his records and part of his collections. The publication of "Imago Mundi" was recommenced, and ten issues (4–13, 1947–56) were produced with the help of subsidies from Swedish cultural foundations. Other notable post-war works by Bagrow include his essay, "The Origin of Ptolemy's Geographia" (Stockholm, 1945); his "Geschichte der Kartographie" (Berlin, 1951); and three parts of "Anecdota Cartographica" (1948–53). At his death he had completed, and was preparing for publication in English, several important works, including a history of Russian cartography. Bagrow's valuable collection of early maps of Russia was acquired in 1956 by the Houghton Library of Harvard College.

Those who worked long with Leo Bagrow learnt that behind a peremptory temper and formidable obstinacy lay warm human sympathies and a strong and genial humour.

R. A. Skelton

Mr. James Kendall

All Jim Kendall's acquaintances, colleagues and friends must have been shocked to hear of his sudden and untimely death on August 24. It is true that he worked hard and played hard, but one would have said he was at the full height of his powers and in a position in the engineering industry for which he was well suited and where he would increasingly extend his influence.

His contribution to the development of nuclear energy in Britain has been considerable, but is not well known. He was responsible for the design and construction of the BEPO pile at Harwell, and for the first production piles at Windscale. These were built at a time when development facilities were limited and naturally are solid, conservative conceptions. How different they are from Kendall's last work with the Atomic Energy Authority, which was

concerned with the design and construction of the Dounreay fast breeder reactor. This is certainly one of the most difficult engineering projects undertaken by the Authority, and one which required day-to-day contact with the large development teams that have had to be brought together for this work. At an earlier period, he was made responsible for the engineering laboratory concerned with the development of components for the gaseous diffusion plant at Capenhurst, and perhaps this contributed to an understanding of the outlook of scientists and to the profitable atmosphere of mutual respect between scientists and engineers working on the Dounreay project.

The fact that Kendall's contribution to the development of atomic energy was not better known was in the main due to personal idiosyncrasies. He joined Sir Christopher Hinton and Sir Leonard Owen in the early days at Risley, after serving with them in the Ministry of Supply through the war-time years. This long association may explain to some extent the success he had in branches of engineering where solid academic backing is usually regarded as advantageous. He had no academic qualifications, and no diplomas or membership of professional institutions—indeed, he positively avoided the possibility. He would not have welcomed public honours or awards no matter where they came from, and if he could avoid signing a written document he would do so; but these strange characteristics did not reduce the regard, and often affection, in which he was held by those who knew him.

In his family life similarly he liked to pretend to be an almost Victorian master in his own house; but this only concealed to a degree how fortunate he had been in his choice of a wife. All our sympathies will be extended to her and his daughter.

L. ROTHERHAM

NEWS and VIEWS

Long Ashton Research Station, Bristol: Dr. H. G. H. Kearns, O.B.E.

DR. H. G. H. KEARNS, who succeeds Prof. T. Wallace as director at Long Ashton (see *Nature*, **180**, 267; 1957), received his scientific training at Wye College and the School of Agriculture, University of Cambridge. After a period of service in the Zoology Department of the University of Bristol, he was appointed to the staff of the Long Ashton Station in 1931 as an adviser in entomology, but later transferred to the post of research entomologist, which he still occupies. From his appointment until the outbreak of war in 1939 his researches were mainly concerned with the biology of pests of horticultural crops, including fruit and market garden and glasshouse crops, and of basket willows. In his work on fruit crops he made outstanding contributions on the control of serious pests of fruits, notably on capsid bugs, apple and plum sawfly, codling moth and raspberry and strawberry pests, and did valuable work on the formulation of sprays, particularly those containing tar and petroleum oils. His investigations played an important part in the development of comprehensive spray programmes for fruit crops, particularly those suitable for the West Midlands fruit areas.

From 1939 onwards he has specialized on the development of spraying machinery and equipment, and during the War he played an important part in designing and developing machines for county agricultural executive committees to carry out contract spraying in orchards. Largely as the result of his efforts, the committees were able to spray 20,000 acres of orchards annually throughout the war period. After the War he turned his attention to problems of automatic spraying machines and equipment, and he designed and built a number of machines for use both in Britain and in the Colonial Territories. Parallel with these investigations, Dr. Kearns has carried out intensive studies of the physical properties of spray fluids and dusts, which have done much to improve the efficiency and economic usage of these materials. During recent years, in conjunction with the Colonial Office, he has worked on the control of pests and diseases of a number of crops in Jamaica and East Africa, including banana, coconut, coffee and cotton, and one of his machines has also been adopted for ground spraying in locust control campaigns. The outstanding services of Dr. Kearns to entomology and agriculture were recognized by the University of Bristol by his appointment to a readership in entomology in 1950, and by the Government by the award of the O.B.E. in 1954. His appointment as director should ensure the continued development of the work of the Station in accordance with the pattern and high standards set by his predecessors.

Human Physiology and Pharmacology at Adelaide: Prof. R. F. Whelan

DR. R. F. WHELAN, who has been appointed at the age of thirty-four to the chair of human physiology and pharmacology in the University of Adelaide, graduated in medicine in The Queen's University of Belfast in 1946. During 1948–51 he was an assistant lecturer in physiology at The Queen's University, and after working for a year with Prof. Henry Barcroft as a research fellow in the Sherrington School of Physiology, he returned in 1952 to the lectureship he now holds at Belfast. His research interests are mainly in the physiology and pharmacology of the human peripheral circulation. At various times he has collaborated with Prof. A. D. M. Greenfield, Dr. J. T. Shepherd, Dr. I. C. Roddie and others in investigating the effects of cold, adrenaline, noradrenaline, intra-arterial injections of gases and the action of the sympathetic nervous system on the blood vessels of the limbs. He has made a special study of the action of histamine, and has developed the use of antihistamines as a tool for investigating the role of histamine in human vascular reactions. At present he is investigating the effects of 5-hydroxytryptamine and its antagonists. He is the author of more than forty papers and holds the degrees of M.D. with high commendation and Ph.D. Dr. Whelan has played an important part in developing the scheme whereby students reading for the honours B.Sc. in physiology at The Queen's University are required to undertake a research project and prepare a paper for publication. He has made short visits to Canada and to several countries in Europe, and will

lecture at various universities in Canada and the United States during next December and January.

Academic Freedom in South Africa

The International Committee on Science and Freedom, in co-operation with the Association of University Teachers, is calling a meeting in the Caxton Hall, Westminster, on November 2, in support of the South African universities in their struggle against compulsory race segregation and government control of higher education for non-whites. The whole of the August issue (No. 9) of the Committee's *Bulletin* (Joint Secretaries, Lime Cottage, 818 Wilmslow Road, Manchester) is devoted to the subject of *apartheid* and its threat to South Africa's universities, and could indeed be described as a working paper for the meeting. The *Bulletin* sets forth in a series of contributions from persons closely concerned with university affairs in South Africa and elsewhere in the British Commonwealth the circumstances and theories which have led to the introduction of the Separate University Education Bill and the consequences that will follow if it becomes law. Father Huddleston points out that the Bill is the logical consequence of the Bantu Education Act, and that with the Native Laws Amendment Bill, simultaneously introduced, which makes it criminal, in certain circumstances, for an African to worship in the same church as his European fellow Christian, and enables the Minister of Native Affairs to prevent any kind of relation, social, political or religious, between the two great South African races in their own land, threatens South Africa's own culture and civilization. Dr. J. W. Cook, of the University of Exeter, who is to be chairman of the November meeting, writes on university traditions in the British Commonwealth, showing how the traditional standards of Western universities have been successfully put into operation in university institutions established in multiracial communities in the British Commonwealth outside South Africa.

Dr. Edgar Brookes, of Natal University, explains the ideology of *apartheid*, and the Hon. A. van der Sandt Centlivres, Chief Justice of South Africa during 1950–57, sums up the issues involved in the Government's proposals for racial segregation in the universities, while Prof. D. Stuart, of Fort Hare University College, shows how the proposed transfer of Fort Hare University College to government control, and also of all higher education for non-whites, would affect the status of staff and students and the standard of teaching. He also describes the philosophy of education which underlies the Government's proposals and will guide it in administering the non-white colleges. The case for *apartheid* is presented by Prof. H. C. Stoker, of Potchefstroom University, who, however, limits himself to the strictly theoretical arguments and does not consider the practical issues, especially the financial difficulties. He draws a distinction between academic freedom and university freedom, which, while making a valid point about the relation between a university and the society in which it exists, seems a little strained when applied to the present context. All in all, the *Bulletin* gives a fair and concise statement of the issues and of the impossibility of reconciling the proposals of the South African Government with the ideals and traditions of the university as accepted and practised elsewhere in the British Commonwealth and throughout the Western world.

European Baccalaureate

A 'European' baccalaureate diploma, recognized by Belgium, France, the Federal Republic of Germany, Italy, Luxembourg and the Netherlands, is to be awarded to students attending the European School in Luxembourg. Governments of the six countries recently signed an agreement officially establishing the School on an international basis for primary and secondary studies. The venture was started in 1953, when an international infant and primary school was opened in Luxembourg for children of members of the European Coal and Steel Authority. Educational advisors from the six countries concerned were later asked by the Authority to extend the School's scope by devising a system of secondary education along the same lines. Methods proposed, which have now been agreed by Ministers of Education in each country, had to provide a comprehensive secondary school programme in four languages—French, German, Italian and Dutch—in which each child could follow studies in his mother tongue. The courses had also to fulfil the requirements of the educational systems of all the six countries so that the children would not be at a disadvantage when they returned home; a synthesis of the various national programmes has been worked out.

The study of modern languages is given an important place in the curriculum, and international exchanges of all kinds are encouraged. Such exchanges are helped by the fact that, from the second year, pupils of different nationalities are given communal lessons in history, geography, biology and, later, in physics, chemistry and art history. According to the recent agreement, students will be examined for the 'European' baccalaureate by an international 'jury' headed by a university professor selected from each of the countries in turn. Successful candidates will be allowed access to universities or other institutions of higher learning in any of the six countries.

Journal of the University of Madras: Centenary Number

The Universities of Madras, Calcutta and Bombay were founded in 1857, the year of the Indian Mutiny. Now, in more peaceful times, Madras has produced the centenary number of its *Journal* (The Registrar, University, Madras, 5. Rs. 4.00). The issue contains twenty-two articles from scientists in many countries. These include: "The Optical Behaviour of Polycrystalline Solids" by Sir C. V. Raman; "On a New Member of the Cylindrocapsaceae" by M. O. P. Iyengar of the University of Madras; "Metamorphic Geology: Reflexions on Its Past, Present and Future" by H. H. Read; "The International Geophysical Year" by Athelstan Spilhaus, a lecture that was delivered at the University in November 1956; "The Elementary Theory of Population Growth" by J. B. S. Haldane. B. B. Dey's "Fifty Years of Chemistry in Indian Universities" is of considerable general interest, since it illustrates the growing importance of science in India. The *Journal* also contains a résumé of the work of the various scientific departments. The number of these appears to be growing rapidly: the oldest has been in existence for only a quarter of a century and there are now ten. The Department of Geology and Geophysics was founded as recently as 1952.

Conservation of Natural Resources

"The Conservation of Natural Resources" is a series of lectures delivered at the Institution of Civil Engineers during 1956 (London: Institution of Civil Engineers, 1957. 17*s*. 6*d*.; 7*s*. 6*d*. to members). The topic is a vital one for the whole world and particularly so in a small crowded country like Great Britain. Although the primary responsibility for action in this field lies with the Government it is the engineer who has to appraise and solve the problem. There are seven lectures in all. "The Engineer's Contribution to the Conservation of Natural Resources" by Sir Harold Hartley deals mainly with the past. Prof. W. R. Jones in "Mineral Resources" points out that since we have plenty of iron, aluminium and magnesium in the sea the future of a steel/light alloy/concrete economy is assured. Prof. L. Dudley Stamp deals with the "Conservation of Land". He stresses the importance of reclamation and making the most of what land we have in a country with only half an acre per capita. One acre of fertile land is needed on an average to feed one person. Sir Hugh Beaver describes the damage done by air pollution, the annual cost of which was recently estimated at £260,000,000. Sulphur is the main offender, so that gasification of coal would reduce this figure considerably. Dr. W. H. J. Vernon lectured on "The Conservation and Corrosion of Metals" and R. M. Finch, the city engineer of Nottingham, describes the way in which waste materials, such as slag, sewage, refuse and ash, can be used, and the reclamation of derelict land. He gave an encouraging account of the steps taken in Nottingham.

Life in Oceanic Trenches

The first volume of the *Galathea* Reports to be issued (Scientific Results of the Danish Deep-Sea Expedition round the World, 1950–52. Vol. 2. Pp. 253+4 plates. Copenhagen: Danish Scientific Press, 1956. 75 Danish kr.) is devoted to papers on animals obtained by the Expedition in depths mainly greater than 6,000 m. When it is realized that only one trawl haul had been made on the sea-bed at this depth (in 1948, by the Swedish *Albatross* Expedition) before the *Galathea* Expedition set sail, the importance of this volume is immediately apparent. It contains almost the entire record of creatures existing in the hadal depths of the ocean from 6,000 m. to below 10,000 m. The examination of this material has been hastened because of its importance, and the results are presented before any of the other findings of the Expedition. The leaders of this Expedition have established a new nomenclature for the oceanic depths: the term 'abyss' is now limited to the depths between approximately 3,000 m. and 6,000 m., that is to say, the greater part of the oceanic floor; the oceanic trenches below 6,000 m. are referred to as the 'hadal zone'. The distinction seems valid, for the fauna of these trenches is greatly different from that of the level oceanic floor. The hadal fauna described in this volume includes Actinaria, hydroids, an octocoral, holothurians (the dominant group of the hadal fauna), crinoids, polychaetes, isopods, pycnogonids and tanaid crustaceans. More than one hundred specimens belonging to five phyla were taken below 10,000 m. The greater part of the hadal species were new to science, but most of them belonged to genera already known. Where new genera are described there is a tendency, strongly to be deplored, to name them after the ship—*Galatheanthemum*, *Galatheathuria*, *Galathealinum* and *Galatheathauma* are new genera from the hadal or abyssal depths, and not one of them belongs to the family Galatheidae, or even to the same phylum as *Galathea*. But this is a very minor criticism of a volume which will remain the chief or only reference source for the hadal fauna for decades.

Simple Investigations in Biology

The place of the amateur in biological investigation has been brought out by J. E. Marson, rural science organizer to the East Suffolk Education Committee. As a result of investigations in various parts of Britain, Marson showed that nymphs of the water boatman, *Notonecta*, were to be found in ponds in the West Riding of Yorkshire in the summer and early autumn while adults were found at all times of the year; in east Suffolk *Notonecta* nymphs can be found in summer and *Notonecta* adults can only be found in autumn when there are very few nymphs. If Marson's statements are correct, then in the West Riding of Yorkshire the adults live until the year after they are nymphs, while in east Suffolk they die during the same year as they are nymphs. In an article in *School Nature Study* (52, No. 208; July 1957) Marson indicates the value of such observations to schoolchildren and asks for the help of children throughout Britain in preparing a national inquiry into the life-cycle of *Notonecta*.

Zoological Nomenclature

The International Commission on Zoological Nomenclature gives notice that, as from March 30, 1958, it will start voting on the following cases involving the possible use of its plenary powers for the purpose specified against each entry. Full details of these cases were published on September 30 in the *Bulletin of Zoological Nomenclature* (13, Part 9): (1) *Phrynosoma* Wiegmann, 1828, validation (Cl. Reptilia, Order Squamata); (2) *Pentila* Westwood, [1851], validation, and designation for, and for *Liptena* Westwood, [1851], of type species (Cl. Insecta, Order Lepidoptera); (3) *Centris* Fabricius, 1804, designation of type species for; *dimidiata* Fabricius, validation (Cl. Insecta, Order Hymenoptera); (4) *adspersus* Rathke, 1837 (*Palaemon*), protection (Cl. Crustacea, Order Decapoda). A proposal is also made for the adoption of a declaration on the question of the use of the diæresis sign for zoological names. Comments should be sent as soon as possible in duplicate to Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

Sunspots during November–December 1956

Two Circulars, Nos. 75 and 76, of the United States Naval Observatory, by Winifred Sawtell Cameron, give the results of the measurements of sunspots secured at the U.S. Naval Observatory or at the Mt. Wilson Observatory; these results are a continuation of those published in the *Monthly Weather Review* from February 1, 1927, until December 31, 1947. The data appear in tabular form, a full explanation being given of the symbols used. In addition, No. 77, "Solar Summary for 1956", provides additional data and includes for each day a summary of the results for each group which was numbered at Mt. Wilson, a table containing only four entries dealing with unnumbered groups, and a table comprising fifty entries of recurrent groups.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: G. Gamble (agricultural officer, Kenya), provincial agricultural officer, Kenya; J. V. Webdale (agricultural officer, Tanganyika), agricultural officer, Zanzibar; W. J. Harrison (assistant conservator of forests, Western Nigeria), senior assistant conservator of forests, Western Nigeria; H. A. Jones (senior geologist, Department of Geological Survey, Federation of Nigeria), principal geologist, Department of Geological Survey, Federation of Nigeria; W. H. Macleod (senior geologist, Department of Geological Survey, Federation of Nigeria), assistant director, Department of Geological Survey, Federation of Nigeria; S. W. Morel (geologist, Nyasaland), geologist, class 1, Cyprus; R. C. Pargeter (senior geologist, Department of Geological Survey, Federation of Nigeria), assistant director, Department of Geological Survey, Federation of Nigeria; D. C. Hendriks (surveyor, Public Works Department, Jamaica), senior surveyor, Public Works Department, Jamaica; H. C. W. Guy (livestock improvement officer, Kenya), principal livestock improvement officer, Kenya; D. F. Golliger, agricultural officer, British Guiana; I. A. D. Robertson, entomologist, Tanganyika; P. A. Thompson, agricultural officer, Fiji; C. R. Wallace, entomologist, St. Helena; A. S. Cook, temporary industrial chemist, Eastern Nigeria; N. V. Williams, fisheries officer, Northern Rhodesia; M. Crown, assistant conservator of forests, Northern Rhodesia; P. R. Reid, assistant conservator of forests, Federation of Nigeria; R. L. Clark, supernumerary surveyor, British Solomon Islands Protectorate; M. A. R. Cooper, surveyor, Federation of Nigeria; J. G. Olliver, technical officer, Survey Department, Kenya; D. Branagan, veterinary officer, Tanganyika; E. Forest, veterinary officer, Jamaica; A. S. Turnbull, veterinary officer, Jamaica; R. C. Smart, spectrographer, Uganda.

University News: University College of North Staffordshire

The following appointments in the University College of North Staffordshire have been made: Dr. D. J. Bartholomew to a lectureship in social statistics; Dr. E. Corinaldesi to a lectureship in mathematics.

The Polymer Corporation Research Studentship founded at the College in 1954 by the Polymer Corporation of Sarnia, Canada, has been elevated to a post-doctoral Research Fellowship. P. P. Rutherford of Trinity College, Dublin, has been appointed Research Fellow and will collaborate with Dr. P. H. Plesch on cationic polymerization.

The National Coal Board has presented £3,000 to the College for research in the stratigraphy of the North Staffordshire coalfield. Dr. J. R. Haynes has been appointed to work on this project under the direction of Prof. F. W. Cope in the Department of Geology. Unilever Ltd. has given £2,700 to the College for fellowships in the Department of Chemistry.

From October 1958, the College will provide opportunities for students, with no qualification in science at the advanced level of the General Certificate of Education, to take in their first year an additional course which will enable them, if successful, to proceed to the degree of B.A. with honours with at least one science subject as a principal subject. Two principal subjects are required for the degree. Fifteen special places will be reserved annually for candidates for such courses, who must qualify for entrance in the normal way. Further information may be obtained from the Registrar.

Announcements

J. F. D. Greenhalgh, of the Rowett Research Institute, Aberdeen, has been awarded a Drummond Junior Fellowship in nutrition for the year 1957–58.

Awards for study in statistics by persons whose primary field is not statistics but one of the physical, biological or social sciences to which statistics can be applied are offered by the Department of Statistics of the University of Chicago. The awards range from 3,600 to 5,000 dollars on the basis of residence for eleven months. The closing date for application for the academic year 1958–59 is February 15, 1958. Further information can be obtained from the Department of Statistics, Eckhart Hall, University of Chicago, Chicago 37, Illinois.

The seventh International Cancer Congress will take place at the Royal Festival Hall, London, during July 6–12, 1958. Enrolment forms must be received at the Congress Office (45 Lincoln's Inn Fields, London, W.C.2) by January 1, 1958, if a late fee is not to be incurred. Registration forms may be obtained from the Secretary-General at that address.

The ninth International Botanical Congress will be held in Montreal during August 19–29, 1959, at McGill University and the University of Montreal. The programme will include papers and symposia related to all branches of pure and applied botany. A first circular giving information on programmes, accommodation, excursions, and other details will be available early in 1958. Further information can be obtained from Dr. C. Frankton, Secretary-General, Ninth International Botanical Congress, Science Service Building, Ottawa, Ontario.

The Fifteenth International Congress of Zoology, to be held in London in July 1958, will consider for final approval and adoption the new text of the International Code for Zoological Nomenclature as revised by the preceding Congresses held in Paris in 1948 and Copenhagen in 1953. In order to relieve the Congress of some of the work involved in the scrutiny of the draft Code, a Colloquium on Zoological Nomenclature is being organized by the International Trust, to be held in London during the week beginning July 9, 1958, prior to the opening of the Congress. Invitations to the Colloquium have already been issued by the Trust to a large number of zoologists known to be interested in zoological nomenclature, and further invitations to the Colloquium will be issued by the Trust to any other members of the Congress who express a desire to take part in its discussions.

Erratum. Reference was made in *Nature* of August 17, p. 321, to a paper by Mr. I. F. Long (not H. F. Long as printed) on instruments for micrometeorological measurements. In the article it was stated that ". . . the dew-point is roughly the mean of the dry- and wet-bulb temperatures". This is, as several correspondents have pointed out, incorrect; the wet-bulb temperature is approximately the mean of the dry-bulb and dew-point temperatures, as stated correctly in the original paper.

BILINGUALISM IN EDUCATION

A JOINT meeting of Sections L (Education) and J (Psychology) of the British Association devoted to "Bilingualism in Education" was held in Dublin on September 9. Three papers were read, and they were followed by discussion.

The first was given by Sir Ben Bowen Thomas, Permanent Secretary of the Welsh Department of the Ministry of Education. His subject was "An Administrator's Approach to the Implementation of a Bilingual Education Policy". He defined a bilingual policy in education as one which is designed to enable the average pupil to attain a mastery of his mother tongue and a working competence in the second language current within his society, and if possible to achieve this by the time the pupil reaches his twelfth year, and in any event not later than the end of his period of compulsory education. That the Welsh language should still be standing up to English at all looked like a bit of unrealistic importunity, but this reflected the will to survive of "a strange, intelligent people".

An administrator does not lay down general policy; he must understand it and, within the limits of statutory provision and financial resources, devise ways and means of giving it effect. Education policy in general is justified and sustained by reference to public opinion, both national and local. The policy of bilingualism in education is the result of three social forces, namely: a respect for tradition, the will to survive, and a sense of fair play. An administrator will seek to implement it in a way that supports trends that favour it and gives no offence to forces that may be opposed to it. He has to devise a policy in consultation with local education authorities and have confidence in them to apply it in varying ways. He will not associate bilingualism with political controversy, but deal with it as an educational issue.

In England and Wales, the Ministry places direct responsibility for it on its Welsh Department. Successive Ministers have pronounced in its favour. The administrator implements it according to the provisions of the Education Acts. Three sections of the Education Act of 1944 concern it: the first asks the Minister to promote the education of the people and develop institutions devoted to that purpose. Pre-eminent among these in Wales is the Welsh language. Section 62 requires the Minister to see that enough teachers are forthcoming, including the right kinds. Section 76 provides, with certain safeguards, that children shall be educated according to the wishes of their parents. The administration of these sections means that bilingualism in Welsh education has been increasingly clarified. More competent bilingual teachers have been employed, suitable educational equipment, including more and better books, has been provided, and the range of choice for parents is wider than it used to be, particularly after the increase in the number of Welsh-language schools in urban areas.

Welsh local education authorities have acted singly and collectively. Some have appointed language organizers, have stimulated the production of suitable text-books, and have formulated clear bilingual policies in terms of school organization. Their collective instrument is the Welsh Joint Education Committee, which is working, with the University of Wales, to break the vicious circle of the lack of qualified graduates and teachers due to secondary schools not sending suitably equipped students to the university and the training college, which is due in turn to lack of qualified bilingual teachers in secondary schools. It is subsidizing competent research into bilingualism in education, because there is now great scope for parading prejudices and superficial impressions about bilingualism as authoritative views. This is a process which is exercising a bad influence on public opinion, making unnecessary difficulties for some local authorities at a critical stage of their efforts to apply sound educational policies. Compulsion is out of the question. The conclusion of the Central Advisory Council for Education (Wales) still holds: "We do not anticipate that a measure that would in any way upset the present delicately adjusted equilibrium of educational administration would react at all favourably upon the place of the Welsh language in the schools". If this policy of bilingualism in education is to succeed, statesmen must be able to count on the support of public opinion and administrators, and teachers and parents must have confidence in one another.

The second paper was given by Mr. J. R. Morrison, a Gaelic-speaking Scotsman, who is now on the staff of the Education Department in the University College of Wales, Aberystwyth. He gave some interesting summaries of psychological research work that had been undertaken in Wales, Scotland and Canada, concluding that not enough has been done under satisfactory conditions to justify firm conclusions of any kind.

The results of the Welsh experiments seemed to establish that reactions to emotionally charged words vary according to the language in which the bilingual child hears them: for example, 'nasty', 'wicked', 'sister', when spoken in Welsh to a bilingual child, produced quicker reactions than the English words, whereas 'lazy' had a greater emotional impact in English for the same children, perhaps because English was the dominating language in the school investigated. Girls seem to be more favourably disposed to bilingualism than boys, and children of Welsh-speaking mothers more so than those of Welsh-speaking fathers. Bilingual children usually scored less in tests of intelligence and of English attainment, but in non-verbal intelligence tests they were nearly or quite equal to monoglots, especially if the test used had no time limit. It was only a minority of children that was definitely equally at home in both languages.

Mr. Morrison described in some detail the results of an investigation by a Canadian neurologist. He seemed to have established that the speech areas of the brain begin to lose their sensitivity after a child reaches the age of ten years, and that they are senescent by the age of fourteen. If this is so, the period of primary education is of vital significance for bilingualism. Mr. Morrison concluded that controlled experimentation on a much wider scale than anything that has yet been attempted is neces-

sary before the complexities of the problem can be unravelled and reliable educational guidance given to teachers.

The third paper was given by Prof. E. F. O'Doherty, professor of logic and psychology in University College, Dublin. He dealt with some educational aspects of bilingualism.

In his view, the emotional life of a large number of children is disturbed by the pseudo-bilingualism in which Irish children find themselves in their early years, because they came from English-speaking homes but received their instruction, from their earliest years, through the Irish language. He maintained that the language of the home, whatever it is, is the child's native language, and that it is a mistake to confuse this with the ancestral language of the people to whom he belongs. In nearly all countries there is a bilingual problem, and in nearly all the hundred or more studies available on the topic, investigators have consistently recommended that children should be taught their native, that is, home, language and in other subjects through that medium. Language, a system of symbols, can become a symbol of a different kind—it can become a symbol of nationality or of culture, or of lack of culture; as a symbol of political independence or of nationality it can be valuable, but as a symbol it is dangerous because it may take precedence over the thing that it symbolizes. The primary purpose of language is a social one, and the first society in which it is acquired is the home. The language of the home is always the child's native language, and his mother tongue. To confuse the native language with the conception of an ancestral language may inflict great harm, because it means the by-passing of the child's normal means of social intercourse in favour of what for many, though not all, is the ancestral language. This has many undesirable effects.

It is also important, Prof. O'Doherty said, to distinguish between bilingualism and pseudo-bilingualism. The latter is the position of a person who has achieved a mastery, proportioned to his age and social group, over one means of social intercourse and who has also acquired some knowledge of another means of communication without mastering it. A bilingual person is one who has two vernaculars. This is a rare phenomenon indeed compared with the number of pseudo-bilinguals in any population. Although research is incomplete, there is no denying the impressiveness of the conclusions that monoglot children do better in intelligence tests than their bilingual and pseudo-bilingual brothers. Very often the problem of bilingualism is decided on grounds other than the intelligence or the welfare of the children—politics, tradition, culture, have provided powerful incentives. Where that has happened, bad psychology, bad educational philosophy and bad educational practice have crept in. The emotional life of a large number of children is disturbed by the pseudo-bilingual situation. Unconscious disturbances precipitated by the total or partial breakdown in communication due to the language barrier can produce long-range effects of some magnitude. In Ireland their contribution to the problem of emigration should not be under-estimated.

In the discussion which followed, speakers included teachers from the universities, training colleges and primary schools. On the whole, they expressed fixed attitudes to the subject, and did not bring to the discussion an open-minded willingness to elucidate the subject in its numerous facets. It was therefore inconclusive and rather disappointing. Charge was met by counter-charge, one body of experience was pitted against another, and the points made came entirely from the Irish situation, in which the great majority of the members of the joint session were involved.

RESEARCH ON GELATIN AND GLUE

THE conference on "Recent Advances in Gelatin and Glue Research", organized by the British Gelatine and Glue Research Association, and held in Cambridge during July 1–5, attracted 150 participants. The discussion which ensued after each group of papers was evidence of the success of the conference. Discussions were stimulated in part by the excellent standard of the papers and by the fact that the aim was to discuss but a single protein, albeit one of tremendous physiological and industrial importance. It is hoped to publish the proceedings before the end of this year, edited by G. Stainsby (Pergamon Press, Ltd.).

At the opening ceremony, Mr. S. G. Hudson, chairman of the Research Association, included in his preface to the Conference an especial welcome to the overseas visitors. The Conference was formally opened by Prof. F. J. W. Roughton, one of the visitors to the Association appointed by the Department of Scientific and Industrial Research. He then introduced Prof. L. Pauling, who gave the Conference Lecture, "Polypeptide Chains in Proteins". In proposing a vote of thanks to Prof. Pauling, Mr. I. H. Chayen (British Glues and Chemicals, Ltd.) stressed the interdependence of technology and fundamental science, and emphasized the especial need of the gelatine and glue industry for fundamental research in the protein field.

Prof. Pauling outlined the development of the modern concept of the helical structure of collagen from the earlier classical experiments of Astbury, Bernal and Fankuchen. Although, by admission, Prof. Pauling discussed few new results beyond the idea that hydrogen bonding at the backbone might be at 180° rather than 120°, the lecture set the tone of the meetings. At all the later sessions the helical concept was much in evidence. Sessions were devoted to various subjects, each session being introduced by a speaker who outlined its scope and background, as follows: (1) structure, properties, origin of animal connective tissue (introduced by Prof. K. W. Gustavson, Swedish Tanners Research Association); (2) soluble collagens and molecular weight, shape and structure of gelatins (Dr. J. Pouradier, Kodak-Pathé, Paris); (3) synthetic polypeptides containing proline (Dr. C. H. Bamford, Courtaulds, Maidenhead); (4) conversion of collagen to gelatin and chemical composition (Mr. A. G. Ward, British Gelatine and Glue Research Association); (5) chemical and physical properties of gelatin and glue (Prof. J. D. Ferry, University of Wisconsin); (6) relation of properties to uses (Mr. J. N. Blake, Richard Hodgson and Sons, Ltd., Beverley).

Discussion on the structure of collagen was concerned with the relative merits of the two structures

I and II (Rich and Crick, 1955). The latter structure is preferred, although there is no evidence that structure I is not also present. Structure II, demanding that every third residue be glycine, imposes a sequence reminiscent of the Bergmann hypothesis. Although there is chemical evidence for the repeating sequence gly-pro-hypro, it is cogent to point out the fate of that earlier hypothesis.

Much would seem to depend upon the degree of identity of the constituent chains of the helix (Burge, Cowan and McGavin). Evidence advanced by Boedtker and Doty (1956) suggests that the chains may not be identical.

A paper by G. N. Ramachandran (Madras), in which the modification of collagen and gelatin by chemical means was discussed, raised the question of the transformation of collagen to elastin (Burton *et al.*, 1955), and it was suggested by Partridge in discussion that the term elastin is too often used for signifying a change in physical properties of collagen fibres rather than for describing a definite fibre which has a characteristic amino-acid pattern distinct from that of collagen. That no discussion of the possibility of transforming collagen into elastin by chemical means took place was probably the one failure of the Conference, although it may indicate current opinion. Stoichiometrically, the change from collagen to elastin would involve cataclysmic changes, and from the accepted amino-acid patterns of the two proteins, 100,000 gm. of collagen could only provide amino-acids for 20,000 gm. of elastin. Far more precise and analytical studies are required following the treatment of collagenous tissue with alkaline buffers, and sodium periodate.

Papers on the biosynthesis of collagen (D. S. Jackson, S. Fitton Jackson and R. H. Smith) suggested that this involves the incorporation of proline into peptide linkage in an amount equal to proline plus hydroxyproline ; residues of the latter appearing as a result of oxidation. It is probable that elaboration of banded fibrils is preceded by the formation of a hydroxyproline-rich precursor, and available evidence suggests that synthesis of a soluble precursor in the fibroblasts is followed by extracellular aggregation with the ultimate formation of insoluble fibres. To what extent the aggregation involves the formation of additional co-valent bonds is not known ; neither is it certain that degradation, even under the mildest of conditions, is a reversal of the synthetic pathway. Considerable discussion took place upon the relationship between collagen, soluble collagen (procollagen, etc.) and gelatin, "a relationship still in a state of confusion". Procollagen (acid citrate soluble ; molecular weight 3×10^5) undergoes denaturation upon warming, and two fractions α (molecular weight 80,000, V. N. Orekovich and V. O. Shpikiter, Academy of Medical Sciences, Moscow ; 120,000, P. Doty and T. Nishihara, of Harvard) and β (molecular weight 130,000, Orekovich and Shpikiter ; 230,000, Doty and Nishihara) are formed. The latter workers indicate that the β-fraction is converted into the α-fraction by means of alkali or by long periods at 40° C. They further suggested that the triple helix, demanded by X-ray analyses, may be produced by the folding back of the longer polypeptide chain.

The molecule of procollagen may not contain merely two subunits α and β, since there is, as yet, no evidence to suggest that the α- and β-chains are monodisperse.

That the situation may be more complicated was indicated by a paper by A. Courts and G. Stainsby (British Gelatine and Glue Research Association), which stressed the disparity between molecular weights found by light-scattering techniques (M_w) and by end-group assay (C_n). If one accepts the former as a significant measurement, gelatin of molecular weight 250,000 must have more than one chain (possibly three or four). Since it contains no cystine, alternative cross-linkages must exist. The suggestion of J. Pouradier and his collaborators that aldehydes are present in gelatin and native collagen deserves further study, since it was indicated that such molecules might act as bifunctional reagents. Somewhat at variance with the paper by Courts and Stainsby was that by A. Veis (Armour, Chicago), in which it was suggested that alkali-process gelatin is a linear single-chain polypeptide, whereas acid-process gelatins are "multistranded lateral aggregates of polypeptide chains not in typical Gaussian coil configuration". The work of Courts and Stainsby indicates that gelatin from a limed source is multi-chain, but that acid-process gelatin gave somewhat anomalous results.

Considerable theoretical and practical interest is attached to the changes which occur during the conversion of collagen to gelatin. End-group studies indicate the absence of terminal residues in collagen (whether they are absent, or combined, or fail to react, or are undetectable in the vast molecule is not known). Upon decalcification and alkaline pretreatment of ossein (pH 14 at 20° for six days) terminal groups are exposed equivalent in amount to those in the derived gelatin (Courts). By treatment with hydrogen-bond breakers at 20° or by warming to 40–60° the 'parent' gelatin passes into solution. It is supposed that pretreatment leads to fission of peptide bonds, and the presence of up to twelve amino-acids in terminal positions suggests that this fission must be a random process. Whether pretreatment does cause fission of peptide bonds is uncertain. No mention was made of the position of mucopolysaccharides in the build-up of the collagen molecule, and in the degradations induced by decalcification and alkaline pretreatment of ossein.

The session on amino-acid composition reflected the tremendous debt owed to the ion-exchange method of Moore and Stein (itself based upon the ideas of Martin and Synge and their co-workers). The comparative analyses of J. E. Eastoe and A. A. Leach (British Gelatine and Glue Research Association) and of M. Watson demonstrate overall similarities of collagens and gelatins from different species and indicate variations which may be significant. The full value of this work will only be realized if corresponding physical studies are carried out. In particular, the observations provide a basis for further investigations into the correlations between fibrillar stability and hydroxyproline stability (cf. Gustavson).

The discussion on gel rigidity centred around the work of P. R. Saunders and A. G. Ward (British Gelatine and Glue Research Association), who showed that rigidity is independent of molecular weight from less than 70,000 upwards. Degradation by a variety of proteases and by acid follows the same pathway, although it is unlikely that the same sites in the molecule(s) are attacked by papain, trypsin, chymotrypsin, pepsin and acid. P. Davis and J. W. Janus (Kodak Research Laboratories, Harrow) reported the

results of work which supported the view of Grabar (1950), that there is correlation between guanidine side-chains and the protective colloid action and rate of setting of gelatins. The use by Davis of the hypobromite reaction as a means of eliminating guanidine from gelatin cannot be regarded as unequivocal since the reaction mechanism, involving as it does 5 to 6 molecules of hypobromite per guanidine group, is not known. It may well involve side-chains other than guanidine. One pertinent question which received no answer was why soluble collagen does not gel until it has been converted into gelatin although the 'density' of guanidine groups is identical.

The session on synthetic polypeptides focused attention upon the structural information which X-ray and infra-red analyses have provided. It is on such information that present-day views of the structure of collagen are more than a little dependent. With the production of linear polymers of all the individual amino-acids and of some of the vast number of possible co-polymers, it will increasingly be possible to interpret the infra-red spectra of proteins. Indeed, the value of infra-red analysis depends upon the synthesis and analysis of such type substances.

The gelatine and glue industry should also take note of synthetic polymers, since they may ultimately provide means for the 'tailor making' of compounds for individual purposes. In fact, such polymers may be to gelatin what synthetic rubber has been to the natural commodity.

Great credit must go to those who conceived, planned and conducted this Conference. It served many purposes, but most important of all it disseminated information among people of divergent interests. The X-ray crystallographer became aware of properties and problems known to the gelatine industry, and the gelatin manufacturer became more aware of the raw material of his industry and of the structures which produce its peculiar properties, structures which may survive in some form in the derived protein, gelatin. G. R. Tristram

CONTROL OF CHEMICAL ADDITIVES IN FOOD

ADVANCES in science have made available a number of chemicals and newly discovered natural products valuable for their power to aid in the production and utilization of foods. The new, however, is seldom of uncontested virtue. Additives which influence the physical and æsthetic qualities of our foods, and residues of those pesticides which defeat biological enemies, are suspect of affecting adversely the human system. Questions have thus arisen: What risks do we run? How can such risks be kept to a minimum? These have needed both consideration and action, not only in the United Kingdom but also in Canada and the United States, and indeed by the Food and Agriculture Organization and the World Health Organization of the United Nations. It was therefore a happy thought, as the American Bar Association was meeting in London, to hold a joint meeting of the Food Law Institute of the United States, the Food Group of the Society of Chemical Industry, the Society for Analytical Chemistry and the Association of Public Analysts of Great Britain to discuss the control of chemical additives in food. This conference was held on July 26 in London at the Royal Institution.

At the morning session, under the chairmanship of Mr. Charles Wesley Dunn, president of the Food Law Institute of the United States, three papers were given on the official approach to these problems in three different countries, and a fourth on the control of pesticides. At the afternoon session, under the chairmanship of Sir Harry Jephcott, special attention was paid to antibiotics.

American views on additives were stated by Mr. G. P. Larrick and Dr. A. J. Lehman, their paper being read by Mr. John L. Harvey, Deputy Commissioner of Foods and Drugs. Advances in technology have indicated the desirability of amending the present Food, Drugs and Cosmetic Act. In 1950 the Delaney Committee directed attention to the need for more careful control of additives and contaminants. Bills promoting revisions are now before Congress. No new additive should be used until adequately tested by feeding gross quantities for long periods to animals and by finding levels at which no harm occurs. Tests should include consideration given to nutritional effects, clinical and pathological symptoms and effects on reproduction and lactation. Results on one species should be confirmed in another. It is impossible to design a simple or rigid procedure. Moreover, a generous safety factor is desirable in extending to man any application of results obtained on animals. Care in the interpretation of some tests for carcinogens was recommended. It might seem wise to exclude additives which by tests other than oral administration purport to demonstrate potential carcinogenic properties; but in some instances similar results are also given by such common foodstuffs as sugar and lard. The American list of permitted colours has recently been altered by removing three colours, and four others are in process of being removed. None of these colours is carcinogenic so far as is known, but they are not as free from the possibility of being harmful as had previously been believed. Although the addition of chemical substances to food introduced problems, they have served many useful purposes. The conservation of food is necessary, and so is long transportation. Chemical additives enable foods to be available in greater diversity and attractiveness. They also contribute to convenience, thus helping millions of women in the United States to work outside their own homes.

The Canadian view was given in a paper prepared by Dr. C. A. Morrell. To the central question, 'Are the hazards introduced by additives serious?', the answer must be affirmative where large quantities are consumed and negative where only small quantities are consumed. A system of tolerances is thus necessary. Although the Canadian Government regrets interference with private enterprise, consumer confidence is important and definite tolerances must be imposed. The Government must therefore lay down rules and see that they are obeyed. Decisions, however, must clearly be based on sound evidence and be uninfluenced by bureaucracy or caprice. But substances intended to deceive the consumer should never be permitted. The provision of evidence is the duty of industry, but some government research is unavoidable where a conflict of evidence is to be resolved, standards are to be established or methods of analysis are to be devised. Tolerances should be set no higher than is necessary and within what is known to be

safe. A general pattern of tests to determine the safety limit can be laid down, but details will often have to be varied. Administrators must be guided by their own experts. The Food and Agriculture Organization and the World Health Organization might help to resolve differences between experts.

The procedure followed in Great Britain to protect consumers against preventable hazards to health or risks of deception was explained by Dr. N. C. Wright, Chief Scientific Adviser (Food) to the Ministry of Agriculture, Fisheries and Food. Food and Drugs Acts establish principles and provide for enforcement. Where precise guidance is desirable, Ministers can make regulations, which are more easily amended than the parent Acts. Ministers look for guidance on technical amendments to their Food Standards Committee, to which medical experts, nominees from industry and officials from departments are appointed. A sub-committee has been studying the need to bring up to date the Preservative Regulations, which happen to approach most nearly to the control of chemical additives. The method used in such cases has been to ask for representations on a group of potential additives from all interested parties, to supplement this with medical and technical evidence from other sources, and to publish a report containing specific recommendations. Any further representations are then considered before Ministers decide on their action. New regulations can be drafted and laid before Parliament for approval. Recently a new system of restriction of the use of colours has been introduced by regulations. There is now a permitted list of colours, but their use is still prohibited in unprocessed meat, fish or vegetables, or in fruit (apart from one exception) to prevent consumer deception. Regulations are being framed to govern the use of antioxidants. A special panel has been set up to examine the medical aspects of the use of antibiotics.

As spokesman also for the World Health Organization and the Food and Agriculture Organization, Dr. Wright pointed out that diversity of conditions among countries makes complete uniformity of regulations impracticable, but the decisions of governments should be based on the widest measure of agreed scientific opinion and should be in harmony if possible. A conference in Geneva in 1955, followed by meetings of two expert committees, had sought to secure the formulation of general principles, suitable biological tests and uniform interpretation of results.

Dr. E. J. Miller extended the picture of British practice by an account of the special precautions devoted to the reduction of hazards to operators, consumers and wild life from agricultural chemicals. An interdepartmental advisory committee advises government departments of risks and formulates recommendations designed to avoid them. After acceptance, these are publicized in order to secure their adoption, although they do not have the force of law. Tolerances for residues are not at present considered adequately enforceable, and preference is therefore given to restrictive conditions by specifying the crops on which individual pesticides may be used, the maximum dosage and the minimum interval before harvesting. A voluntary scheme exists by which manufacturers notify new developments and co-operate in ensuring safe usage.

The status of antibiotics in relation to food in the United States was discussed in a paper by Dr. H. Welch. The use of two antibiotics for the preservation of uncooked poultry, under limiting conditions, has been approved. Such applications are accepted as being useful by the U.S. Department of Agriculture, and a safe tolerance has been fixed by the Food and Drug Administration. All poultry is cooked so that even the permitted amounts of these antibiotics are completely destroyed. Applications to meat and fish, however, are not considered safe. The occurrence of antibiotics in milk has been surveyed. Mastitis is controlled by injection of antibiotics, chiefly penicillin, into the udder. Until three days later, milk may still contain enough antibiotic to prejudice cheese-making. Samples of fluid market milk have often been found positive for penicillin and more rarely for other antibiotics. There is thus a risk that a small proportion of the population may become sensitive to penicillin and suffer allergic reaction. To protect the public, farmers are being educated to prevent bulk supplies of milk from being contaminated; the hazard is stated on every label of the drug and the doses recommended are being substantially reduced.

Canada, according to Dr. C. A. Morrell and Dr. E. S. Thatcher, is prepared to give antibiotics a trial where practical benefit can be safely achieved without risk to their therapeutic value. Canada permits chlortetracycline and oxytetracycline to be used on fish as well as uncooked poultry. All reasonable precautions for safety are satisfied under the conditions specified. The development of resistant microbial strains has not been found of consequence.

The final paper, by Mr. A. L. Bacharach, gave an individual view of some of the complexities of British law as it might apply to antibiotics and of the alleged health hazards attributed to their use in the food industry. The Therapeutic Substances Act prevents the use of thirteen scheduled antibiotics except by registered practitioners, but three of them can be used conditionally in animal feeding-stuffs. The preservatives regulations do not permit the use of antibiotics in human food. There is, however, no control of the use made by farmers of feeds containing them, and veterinary use can lead to contaminated milk. Antibiotics used in horticulture might leave residues, over which there would be no effective legal control. The interpretation of the law is in some doubt as regards nisin and notatin. Experience of pasteurization belies the alleged hazard of encouraging undesirable organisms. Sensitization due to penicillin in milk has not, in fact, been reported, although American records suggest that there are many potential subjects. The suggestion that food spoilage organisms can give warning of the presence of pathogens was vigorously attacked. It was conceded that more information is needed on the magnitude of oral intake of antibiotic which could evoke response in sensitized individuals, whether the allergy is innate or acquired.

It was a tribute to the character of the papers that discussion mainly re-emphasized points made by the speakers, particularly of the complexities of testing and of analysis, and of the difficulties of administrators in fairly summing up issues involving so many diverse factors. A plea was made that the design of toxicity tests should be left to those who had experience of undertaking them. A decision on the adequacy of testing methods should be realistic. Strict specification of the quality of proposed additives would often save time and trouble both in testing and in analysis. It is not enough that manufacturers should be aware of methods of identification and estimation of additives or residues; this

information must also be made available to all interested analysts. The American system of relaying such information is noteworthy. Where tolerances are fixed, methods of assay can often be simplified by reference to a standard. In matters of doubt, complete unanimity of opinion in all countries is improbable; but free discussion and free exchange of information could assist in reaching sensible conclusions. Piecemeal decisions should be avoided if possible.

Dr. Bernard Oser suggested that while it is not generally possible to legislate for allergic subjects, some protection might be achieved by appropriate labelling.

It was perhaps surprising that Mr. Bacharach's dismissal of some of the fears felt by those who mistrust the use of antibiotics was not contested.

Mr. Wesley Dunn said that the value of the meeting lay in the opportunity it had provided for discussion of a problem common to many interests, thereby making progress towards its ultimate solution. Sir Harry Jephcott, in summing up, thought uniformity had been brought nearer by this international exchange of ideas, and hoped that this had been only the first of many similar joint meetings.

The papers before the conference will be published in the *Food, Drug and Cosmetic Law Journal*.

MORALE IN INDUSTRY

IN 1953, the Acton Society Trust published, under the title "Size and Morale", the results of an inquiry into the statistically observable relationship between the size of a number of otherwise similar undertakings—in a coalfield, in a large industrial organization, in a commercial group—and certain indices of morale among the workers employed in these undertakings (see *Nature*, February 27, 1954). Size was defined according to the numbers of workers on the books. Morale was measured by various indices of which the most important was the negative one of absenteeism—since, to quote the pamphlet in question, "a man can hardly express his identification with his work more clearly than by whether or not he turns up to perform it".

The results of the inquiry were extremely suggestive. In the coalfield studied, not only was lost time found to increase with size, but it was also established statistically that in similar geological conditions output per man-shift tended to be no higher—and was often in fact appreciably lower—in large pits than in small. Various forms of behaviour suggested that workers in small pits showed greater interest in matters associated with their place of work than those in larger pits. Wages did not appear to have any effect on morale, and it was interesting to find this statistically confirmed. A clear relationship was found to exist between size and sick-leave; between size and the number of accidents; and also between size and the length of time taken to recover from an accident. All this evidence was entirely quantitative and not very useful as a guide to policy. The fact that the size of the unit in which people work is related to their behaviour is not an explanation of the relationship. The earlier studies stopped short at statistical demonstration; they made no attempt to explain what they demonstrated in sociological terms.

The next stage of inquiry called for a different approach, the approach of the social scientist working in individual situations. The inquiry has now been completed and a second report issued*. It is a qualitative study which tries to find out the reasons for the higher lost time in large establishments and, where practicable, to draw lessons from management policy.

The inquiry was made in a group of twelve manufacturing units which came as near as possible to the ideal requirements for the research. Units of the group varied in size from about twenty to about four thousand people; five of the units were selected for special investigation.

The works selected for study all offered the same wage-rates and conditions of service and the same sick schemes and pension rates; they followed technically the same patterns of work; they were all situated in a large urban area; they had all been under the same administration for many years. They were all alike in employing for the most part labour of an unskilled or semi-skilled character, the small proportion of craftsmen being mainly occupied with maintenance rather than production. There was no significant difference in the age structure of their working forces—a matter which might well make a difference to time lost after accident or illness—nor in the average length of service.

The inquiry confirmed the inverse size-morale effect and showed that poor morale arises from causes which have nothing to do with the worker's satisfaction in, and psychological identification with, his work. Many reasons for good morale in small units were adduced. One is that very small units cannot carry bad time-keepers—they quickly dismiss them; they cause too much dislocation to be tolerated. Evidence showed that the larger works had more than their statistical share of bad time-keepers. This was also true of grumblers, the rumour-mongers, and the chronically discontented trouble-makers. In the small unit such men are easily identified and, if possible, discharged. In the large unit they are likelier to remain submerged and unrecognized and it is in the large units that they are most likely to be found. The trouble-maker has much more scope in a large group. In the small unit, even if he cannot be discharged, he is comparatively innocuous because his colleagues know all about him and can discount what he says. In the large unit the majority do not know him for what he is, and his influence is consequently far more dangerous. His low morale and his high lost time-rate are contagious, and the morale and time-keeping of the works as a whole consequently suffer.

The most important lesson arising from the inquiry is that increasing size is above all an increasing challenge to management—management in the social even more than in the administrative or technical sense. There are disadvantages in size about which management can do little or nothing. A higher incidence of sickness due to greater likelihood of cross-infection is one of these. The wider catchment area for labour is another. So is the tendency of bad time-keepers and 'bad bargains' generally to gravitate to the larger unit. Other disadvantages of size isolated by the inquiry are not similarly intractable. There is no reason why internal discipline should be increasingly handicapped with increasing size by over-extension of the foreman's span of control. A good foreman with a manageable number of men under his control can generate a positive team spirit as well as performing the negative function of

* Size and Morale. Part II. Acton Society Trust. 3*s*. 6*d*.

checking absenteeism and 'column-dodging'. It is management's job both to select the right foremen (which includes providing the right incentives to their recruitment) and to see that their span of control is suitable.

The importance of intermediate management is one of the obvious lessons of this, as of other related inquiries. In order that respect and trust may be generated, it is necessary both that intermediate positions be filled by men of ability and character and that the system within which they work should allow decisions to be made quickly, unequivocally and comprehensibly at the appropriate point. Both the choice and appointment of subordinates and the devising of the structure of authority is the responsibility of top management. It is for top management to devise, and for intermediate management to operate, that system of communications with which the small unit can dispense but which must grow more complex, with increasing size, if instructions are to be understood and morale-destroying misunderstandings are to be avoided. The need of such a system should not be a permanent and inherent handicap of size.

The real difficulty of the big organization, however, springs from the calls that it makes on managerial ability; these outrun the supply of adequately trained managers. The small unit can get on with managers who are competent technicians and reasonably forceful, fair-minded and intelligent characters; the large unit needs specialists, and these, in the numbers required, simply do not exist. The lost-time rates of the large-scale units, and the inadequate morale of which these are largely the symptom and index, reflect this deficiency. To overcome it is an essential step both towards saving the material waste caused by lost time and towards creating a humanly satisfying climate in large-scale industry.

T. H. Hawkins

CONTROL OF PUBLIC EXPENDITURE ON SCIENTIFIC PROJECTS

THE third report from the Committee of Public Accounts for the Session 1956–57 has recently been issued*. Reference is made in it to the Treasury Minute of January 31, 1957, rejecting the Committee's recommendation that the Comptroller and Auditor-General should have access to such papers and records of the University Grants Committee as related to non-recurrent grants to the universities; and the Committee expresses appreciation of the fact that, by ensuring that in future the accounting officer is better informed as to the projects on which voted money is being spent and by making much additional information available to the Comptroller and Auditor-General, the Treasury has gone some way towards meeting the Committee's wishes. The Committee recommends that the new arrangements proposed by the Treasury should be given a trial over a period of three years, when the matter might be further reviewed.

Among other matters discussed in this report is the grant by the Department of Scientific and Industrial Research to the University of Manchester towards the construction of the radio-telescope at Jodrell Bank. Originally estimated in March 1952 to cost £335,450, including four years running expenses, the cost had risen in May 1953 to £439,616, towards which the Nuffield Foundation had agreed to contribute £200,000 and the Department £230,000, subject to some conditions relating to financial control, including the requirement that the Department should be consulted if any substantial variation from the expenditure detailed in the approved estimate became necessary. The University entrusted the design work and supervision of construction of the telescope to a firm of consultant engineers under an agreement which provided *inter alia* that prior approval of the University should be obtained for any serious modification of the design or in the cost of the work and for any large variations of contracts, which were to be let only with the written authority of the University. Further rises in costs before the work was completed were expected, and in November 1954 the University notified the Department that the May 1953 estimate might be exceeded by £50,000. In October 1955, however, the University informed the Department orally that the increase was likely to be £240,000 and that it had become clear that the design had been changed substantially without the University's approval. A committee of inquiry was set up jointly by the Department, the Nuffield Foundation and the University, and this committee, which reported on March 15, 1956, recorded what the Department described to the Treasury as a very unsatisfactory position as between the University and the consultants. Nevertheless, the Department considered it imperative that the telescope should be completed and recommended a further grant of one-half the cost above the £430,000 already provided, subject to a limit of £130,000.

The Department informed the Committee of Public Accounts that normally it stated the terms under which the grant would be given to a university, and then trusted the university to expend the grant in a reasonably competent manner: the Department would not intervene in negotiations between a university and its contractors. It was also stated in evidence that the engineering consultant changed the design without the concurrence of the University of Manchester, introducing new structural features which materially increased the complexity and cost; but Prof. A. C. B. Lovell, who was primarily responsible for the outline design and lived on the spot, was apparently not even consulted. The Treasury also agreed that expenditure on the telescope had not been properly controlled and administered by the University, which had not adopted the normal procedure of setting up a building sub-committee to process construction throughout: the Treasury has made the establishment of such a committee a condition of a further grant.

Criticizing the Department for not inquiring more closely into the University's arrangements with the consultant engineers and into the system of control over the design and construction work, the Committee of Public Accounts recommends that in future, when Government departments entrust substantial grants to universities for specific projects, they should seek the advice of the University Grants Committee on such matters as definition of contracts, establishment of university sub-committees responsible for executing the projects and any other measures necessary to control and supervize capital expenditure.

* Third Report from the Committee of Public Accounts, Session 1956–57. Pp. 36. (London: H.M. Stationery Office, 1957.) 1s. net.

A LATTICE DISTORTION OF ALKALI CHLORIDE CRYSTALS IN THE PRESENCE OF NUCLEOPROTEIN MICROFIBRILS

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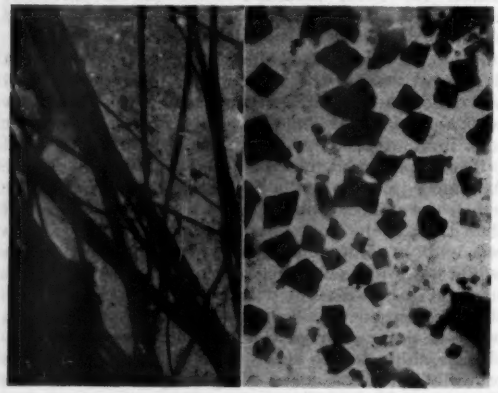
It has been shown[1,2] that on slow evaporation of aqueous solutions of alkali chlorides in the presence of some macromolecular substances, the crystals formed are plate-like and contain oriented fibrous inclusions of macromolecules. This phenomenon has been observed with deoxyribonucleic acid, deoxyribonucleoprotein, bronchial mucoprotein, fibrinogen, carboxymethyl cellulose and sodium alginate. The inclusions consist of slender fibres with diameters of 0·1–0·2 micron and varying in length up to several hundred microns. The smallest diameter of microfibrillar inclusions observed is of the order of 90–120 A., and this is most common for deoxyribonucleoprotein[3]. This order of magnitude apparently conforms to the approximate value for the fundamental dimension, typical for a variety of fibriform bodies[4,5].



a *b*

Fig. 1. (*a*) Electron micrograph of sodium chloride associated with deoxyribonucleoprotein microfibrils. 40 kV. (× *c.* 4,670); (*b*) electron micrograph of sodium chloride crystallites, deposited on 'Formvar' film from 80 per cent methanol solution. 40 kV. (× 4,670)

In the course of separation of microfibrillar inclusions from the host crystal by dissolving the alkali chloride in methanol, it was found that for deoxyribonucleoprotein and deoxyribonucleic acid the microfibrils still retain an appreciable amount of salt (Fig. 1*a*). Even after long-continued washing in methanol and consequent drying *in vacuo* the residual microfibrils, when examined in the electron microscope, continue to give a well-defined electron-diffraction pattern of the alkali chloride, which suggests that the salt crystals are closely associated with the microfibrils of nucleoprotein. The measurement and comparison of these electron-diffraction patterns with the diffraction patterns of the pure alkali chlorides shows that in the case of the salt associated with microfibrils the ratios of the spacings d_{111}/d_{200} and d_{111}/d_{220} are invariably higher than are those for the pure salt.

Table 1. The Ratios of Some Spacings for Pure Alkali Chlorides and Alkali Chloride Crystals associated with Nucleoprotein Microfibrils

Material	No. of specimens	Ratio d_{111}/d_{200} (Calc. 1·1547)	Ratio d_{111}/d_{220} (Calc. 1·6330)	Ratio d_{200}/d_{220} (Calc. 1·4142)
(*a*) Pure alkali chlorides (KCl, NaCl, LiCl)	16	1·155 ±0·006	1·633 ±0·012	1·415 ±0·009
(*b*) Alkali chlorides associated with nucleoprotein microfibrils	19	1·167 ±0·006	1·647 ±0·010	1·414 ±0·006
% deviation		+1·03	+0·857	0·1
Comparison of means of *a* and *b* by *t* test	Degrees of freedom 33	*t* 5·594 *P* 0·001 Highly significant	*t* 3·773 *P* 0·001 Highly significant	*t* 0·411 *P* 0·6–0·7 Not significant

Table 2. Analysis of Variance of the Measurements of Ring Diameters of Pairs of Electron Diffraction Patterns for Alkali Chlorides: KCl, NaCl and LiCl. (*a*) Pure Alkali Chlorides; (*b*) Alkali Chlorides associated with Nucleoprotein Microfibrils

Variables	(*a*) Pure alkali chlorides	(*b*) Alkali chlorides associated with nucleoprotein microfibrils
Main Effects	*P*	*P*
Between:		
Rings	0·001	0·001
Specimens	0·001	0·001
Pairs of readings	0·02–0·01	Not significant
Observers	Not significant	Not significant
Non-circularity of rings	Not significant	Not significant
First-order Interactions		
Rings-specimens	0·001	0·001
Rings-pairs	Not significant	0·01
Other interactions	Not significant	Not significant
Standard error of observations = error mean square	0·083	0·042

Table 3. The Change in the Spacing Ratios for Different Alkali Chlorides associated with Nucleoprotein Microfibrils

Salt	Ratio d_{111}/d_{200}		*t* test *P*	Ratio d_{111}/d_{220}		*t* test *P*
	(*a*) Pure salt	(*b*) Salt associated with microfibrils		(*a*) Pure salt	(*b*) Salt associated with microfibrils	
Potassium chloride	1·154	1·169	0·01–0·001	1·636	1·653	0·1–·05
Sodium chloride	1·155	1·167	0·05–0·02	1·631	1·651	0·02–0·01
Lithium chloride	1·153	1·158	0·2–0·1	1·632	1·637	0·2–0·1

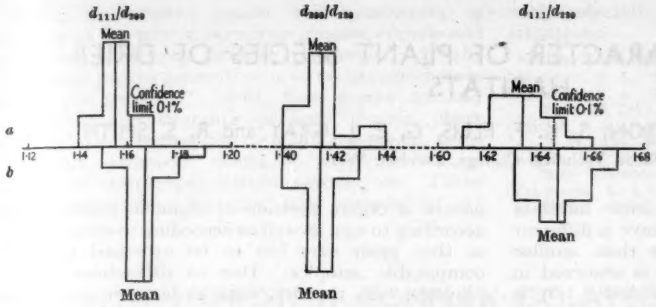


Fig. 2. The distribution of the individual values of the ratios d_{111}/d_{200}, d_{111}/d_{220} and d_{200}/d_{220} for (*a*) the pure alkali chlorides and (*b*) alkali chlorides associated with nucleoprotein microfibrils

A series of sixteen samples of pure sodium, potassium and lithium chloride was examined, microcrystalline deposits being prepared on the 'Formvar' substrate by evaporating saturated solutions (1 part of water and 4 parts of methanol) of salts (Fig. 1*b*).

Similar electron micrographs and diffraction patterns have been taken from the alkali chloride crystals associated with microfibrils of deoxyribonucleic acid and deoxyribonucleoprotein. These include nine samples of sodium chloride, six samples of potassium chloride and four samples of lithium chloride. All diffraction patterns were measured by each of two observers (J. C. W. and P. C. E.) using a glass scale and a × 10 aplanatic lens. The diffraction rings were measured in four diameters, recorded to ± 0·03 mm., and the mean values were used for calculation of the ratios of spacings.

The distribution of the individual values of the ratios d_{111}/d_{200}, d_{111}/d_{220} and d_{200}/d_{220} for the pure alkali chlorides and alkali chlorides associated with microfibrils is shown in Fig. 2. The mean and standard errors for both cases are shown in Table 1 and are also compared by the *t* test.

Whereas the values of the three ratios for the pure alkali chlorides are in good agreement with the expected ones, the ratios of spacings for the alkali chlorides associated with microfibrils reveal a significant lattice distortion of the salt crystallites. This is shown by the abnormally large ratios d_{111}/d_{200} and d_{111}/d_{220} (Table 1).

The 240 measurements made by two observers on the paired diffraction patterns from samples of pure alkali chlorides were examined by analysis of variance,

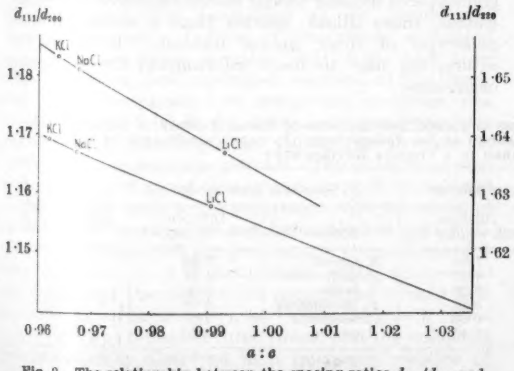


Fig. 3. The relationship between the spacing ratios d_{111}/d_{200} and d_{111}/d_{220} and axial ratio $a : c$

together with similarly treated samples of alkali chlorides associated with nucleoprotein microfibrils (Table 2). The only sources of large significant error are the specimens and ring diameters, as expected. Ring-specimen interactions are much smaller, and indicate only that differences between specimens affect differences between rings. The only other significant main effect is between pairs of pure alkali chlorides, the direction suggesting that this results from thermal expansion. The effect is not observed for the crystallites associated with microfibrils of nucleoprotein, but in this case it is clear from the electronmicrographs (see Figs. 1*a* and *b*) that the crystallites of alkali chloride are appreciably smaller than those of the pure salt. It can be concluded that a number of effects do not add to the error; namely, observer error, lack of circularity of the rings of the diffraction patterns, and higher order interactions. The standard error of the observations is 0·04–0·08 for ring diameters varying from 5·6 to 12·6 mm.

It has already been pointed out[6–9] that some metals prepared in a thin film have an expanded lattice. The general discussion upon the deformation of the cubic *F*-lattice can be found in Zhdanov and Konusov's paper[10,11]. In the present case of the alkali chlorides associated with nucleoprotein microfibrils, the abnormal spacing ratios may be explained by assuming, for example, that the lattice is no longer a cubic but a tetragonal one.

Indeed, for the spacing ratios d_{111}/d_{200} and d_{111}/d_{220} plotted as functions of axial ratio $a : c$ (Fig. 3) the abnormal experimental values of these two ratios for all three alkali chlorides correspond very closely to the same values of $a : c$. That is, for potassium chloride both ratios correspond to $a : c \simeq 0{\cdot}963$, for sodium chloride to $a : c \simeq 0{\cdot}968$, and for lithium chloride to $a : c \simeq 0{\cdot}991$.

It is of interest to note that the lattice distortion does not affect the three alkali chlorides to the same extent (Table 3 and Fig. 3) and appears to follow the atomic numbers and ionic radii of potassium, sodium and lithium. The magnitude of lattice distortion appears to vary directly with the ionic radii of the alkali metals ($\rho = 0{\cdot}01$) and inversely with the polarizing power (ρ 0·01–0·001) and with the lattice energy of the alkali chlorides (ρ 0·05–0·02).

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AN INHERENT CHARACTER OF PLANT SPECIES OF DRIER HABITATS

By Dr. M. L. R. PETTERSSON, S. K. F. ELLIS, G. E. J. GRAY and R. S. SMITH
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THAT angiosperm species of drier habitats (excluding the succulents which have a different metabolic regime) have drier tissues than similar species of moister places, when each is observed in its modal habitat, has become established[1,2]. It is sometimes forgotten that the whole or greater part of this difference might be due to environmentally induced modification, occurring anew in each generation. There is a little direct experimental evidence that at least in some cases the species of drier habitats do in fact have inherently drier tissues, as measured in various ways; though few workers have taken the trouble to compare individuals of such opposed species which have been reared in a common environment, so as to eliminate differences in modification. Thus, Maximov *et al.*[3] found that non-succulent 'xerophytes', such as *Artemisia maritima*, had about twice the vacuolar osmotic pressure of certain 'mesophytes', such as *Erodium ciconium*, which were growing in the same part of the Tiflis Botanical Garden (5+4 species, in nine genera); while Fritsch and Haines[4] appear to find that certain terrestrial algae are inherently drier than certain fresh-water algae (2+2+2 species, in six genera). If this proves to be a general and normal relationship, the inherent character of tissue dryness might be a useful criterion, in breeding for drought resistance, which has not so far been generally used[5].

Consequently some data of 1955–57 should be made known. Six British genera were chosen in which plants were available of two or more species showing known ecological preferences for moister or drier habitats[6]. Comparisons of the fresh-weight/dry-weight ratio, or 'dilation'[6], of comparable laminas were made, within each genus, on plants which had been reared under the same conditions. Three ways were used of eliminating differences due to environmentally induced modification: (*a*) the transplantation of small portions in early spring into standard conditions, so that many new organs could develop during the growing season; (*b*) the comparison of two species growing naturally intermingled in the field, in the same square decimetre or metre; (*c*) the comparison of species raised together from seed in standard artificial conditions.

It is known that dilation, that is, fresh wt./dry wt., varies considerably according to position in organ, nature of organ, position of organ in organism, and according to age, as well as according to environment; so that great care has to be exercised to obtain comparable samples. Due to differences in morphology, size, rhythm, etc., as between genera, one would not expect two plants such as *Quercus robur* L. and *Endymion nonscriptus* (L.) Garcke—of the same community—to have typically the same lamina dilation. But by comparisons within a genus, variance associated with general morphology, etc., can be reduced to a minimum, as in the present comparisons.

Table 1 shows some of our conclusions in condensed form. Each intrageneric comparison shows that the species of the ecologically moister habitat has the greater inherent dilation, the greater inherent fresh-wt./dry-wt. In most separate genera the differences, as so far studied, are already significant. For the group as a whole, the average difference in inherent specific dilation is seen to be more than 40 per cent, and fully significant, with $P \ll 0{\cdot}01$. Several other common species of *Ranunculus* and *Veronica* (perennial section) were studied, and showed the same relationship. In *Veronica*, rearing species from seed, method (*c*), gave confirmatory results. It appears that in *Veronica*, at least, the inherent dry weight of the cell is relatively constant, and that dilation is closely correlated with cell size ($r = +0{\cdot}88$). In the group of six genera studied, there was no association between specific habitat and lamina fresh weight.

When grown under the same conditions, and perhaps for long enough to eliminate previous modifications, Fritsch and Haines[4] found that the dilation in certain green algae increased steeply, from *Pleurococcus naegelli* with $d = 1{\cdot}7$, to *Zygogonium ericetorum* with $d = 6{\cdot}2$, to *Spirogyra* sp. with $d = 24$; their respective normal habitats being tree trunks, etc., the soil surface, and fresh water. Here again inherent internal dryness corresponds to dryness of modal habitat. Since the same relationship is reported from algae and angiosperms, the proposition may be put forward, as a hypothesis for further testing: that among green plants it is normal for a genotype of moister modal habitat to have inherently wetter, more dilate, tissues than a similar related genotype of drier modal habitat. It would be interesting also to have information for non-green organisms.

Table 1. Showing the Relationship between Inherent Dryness of Lamina and Dryness of Modal Habitat, in Intrageneric Comparisons. For this Purpose *Glyceria fluitans* R.Br. is regarded as *Poa fluitans* Scop. In each case Plants of the Two Species had been reared in a Common Environment

Genus	Type and number of comparisons	*A*. Species of moister habitat		*B*. Species of drier habitat		Dilation of *A* / Dilation of *B*
		Species	Dilation fresh wt./dry wt.	Species	Dilation fresh wt./dry wt.	
Ranunculus	*abb*	*R. flammula*	7·50	*R. repens*	5·86	1·28
Hypericum	*a*	*H. tetrapterum*	4·67	*H. perforatum*	4·27	1·09
Primula	*a*	*P. vulgaris*	6·20	*P. veris*	3·02	2·06
Veronica	*aaa*	*V. beccabunga*	8·21	*V. chamaedrys*	4·96	1·66
Centaurea	*a*	*C. scabiosa*	9·05	*C. nemoralis*	7·07	1·28
Poa	*a*	*P. fluitans*	6·45	*P. annua*	5·50	1·17
				$P \ll 0{\cdot}01$		Mean = 1·42

During the present season, this relationship is being tested for certain economic grasses, cereals and vegetables, of known habitat preference. If the relationship proves general, as is to be expected since for the six genera $P \ll 0{\cdot}01$, then a new method is available for selecting progeny during plant breeding. In breeding for drought resistance, tests of drought endurance[5] could be supplemented or replaced by more rapid dilation estimations. There would furthermore be the new possibility of early selection for suitability to medium or moist situations.

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A CAROTENE-PROTEIN COMPLEX ISOLATED FROM GREEN LEAVES

By MITSUO NISHIMURA and KEN TAKAMATSU

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THE occurrence of carotenoid-protein complexes in certain bacteria[1] and animal tissues[2,3] has been reported, but the literature contains no evidence of their existence in green cells. We have lately succeeded in isolating from chloroplasts of green leaves a coloured proteide containing β-carotene as its component. Although the quantity of the carotene existing in this form was found to be only a minute fraction of the total content of the pigment in chloroplasts, it seemed worth while to examine the properties of this new proteide.

The starting materials used were fresh leaves of parsley or spinach or chloroplasts isolated from them, all of which lead to the isolation of the same substance. In most experiments we used parsley leaves which were treated as follows. 4 kgm. (fresh weight) of the leaves was dipped in 3·4 l. of chilled acetone containing 51 ml. of 28 per cent ammoniacal water, and immediately homogenized in a Waring blendor for 3 min. The acetone used was carefully freed from any trace of contaminating ethanol. This and all the subsequent procedures were carried out at temperatures below 0° C. The homogenate was thoroughly ground in a mortar with quartz sand, and the ground material was centrifuged at 1,700*g* for 8 min. To the supernatant fluid an equal volume of cold acetone was added together with 0·5 gm. of cellulose pulp, and the mixture was kept in an ice-bath for 30 min. The dark green precipitate was collected on a Buchner funnel by suction, and washed with 1 litre of cold acetone–water mixture (3 : 1) containing 5 ml. of 28 per cent ammoniacal water to remove chlorophylls and free carotenoids. The pink-coloured precipitate remaining on the funnel was washed first with 1 litre of two-thirds saturated ammonium sulphate solution (*p*H 8·0), and then with 1 litre of half-saturated solution of the same salt. The precipitate, now orange-red in colour, was extracted with 0·05 *M* disodium hydrogen phosphate solution and centrifuged at 7,000*g* for 15 min. to precipitate the insoluble portion. The extraction procedure was performed three times, and the combined extracts were made to 0·1 saturation with the addition of saturated ammonium sulphate solution (*p*H 8·0). After centrifuging off the precipitate, the supernatant was brought to 0·3 saturation with ammonium sulphate, and the orange-red precipitate formed was collected by centrifugation at 7,000*g* (15 min.). This procedure was repeated three times, and the collected precipitate was dissolved in a minimum volume of water and dialysed against pure water. The dialysate was centrifuged at 24,000*g* for 1 hr., supernate discarded, and the precipitate was washed with a minimum quantity of water by centrifugation. Throughout all these procedures precautions should be taken to avoid acidic reaction of the medium, since the proteide coagulates irreversibly at lower *p*H.

The substance thus obtained was orange-red in colour, and was composed of particles of relatively uniform dimension as may be seen from the electron micrograph shown in Fig. 1. It is apparently soluble in water and shows yellow fluorescence. It contains 9·5 per cent nitrogen (on a dry-weight basis) and gives positive biuret and xanthoproteic reactions as well as the carotenoid reaction of Molisch (appearance of blue colour on adding concentrated sulphuric acid). When treated with a hot ethanol–acetone mixture (1 : 1) and afterwards with ethyl ether, it loses 33 per cent of its dry weight, indicating that the substance is of the nature of a lipoprotein. By treatment with ethanol and afterwards with ether or acetone, it is separated into two parts : a yellow pigment showing Molisch's carotenoid reaction and a colourless protein which is no longer soluble in water. (The separation of the pigment part did not occur when the complex was directly treated with ether or acetone without pretreatment with ethanol. When the material was previously denatured by heat or acid, separation of

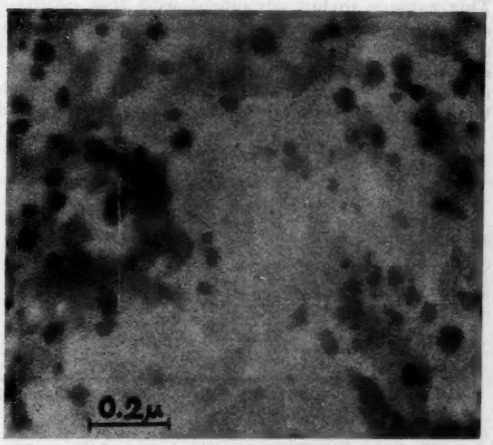

Fig. 1. Electron micrograph of the carotene–protein complex from green leaves (parsley)

the pigment by direct application of ether or acetone could be achieved to some extent; but in this case also the pretreatment with ethanol was necessary for complete separation.) The separated pigment was found, by column and by paper chromatography, to contain a single coloured substance, and when dissolved in *n*-hexane it showed absorption maxima at 452 mμ and 480 mμ with shoulders at 395 mμ and 425 mμ, a spectrum which is precisely identical with that of (all *trans*) β-carotene (Fig. 2). From the absorption measurement of the separated pigment the content of β-carotene in the original complex was calculated to be 2·0 per cent on a dry-weight basis.

The absorption spectrum of the original complex is remarkably different from that of the separated pigment. In Fig. 2 the absorption spectrum of the complex (dissolved in water) is shown with that of the separated pigment (dissolved in *n*-hexane). The complex shows three absorption maxima lying at 280 mμ, 498 mμ and 538 mμ with a shoulder at 460 mμ (Fig. 2). When compared with the spectrum of separated pigment, the two maxima characteristic of the pigment are shifted to longer wave-lengths by about 2×10^3 cm.$^{-1}$ in terms of wave number. The absorption spectrum of the complex is also distinctly different from that of a suspension of β-carotene crystals (*cf.* Shibata[4]). Another remarkable optical property of the complex is that it shows flow birefringence in the dissolved state. Considering the electron-photograph reproduced in Fig. 1, the occurrence of flow birefringence indicates that the particles of the complex are disk-shaped rather than spherical.

From the electron micrograph it was found that the particles are 19 mμ in mean radius with a standard deviation of 6 mμ. If we assume, for the sake of simplicity, a spherical shape for the particles, having a specific volume of 0·75 (in the non-hydrated state), the weight-average particle weight of the complex is estimated to be $5 \cdot 7 \times 10^7$. In Fig. 3 is shown the sedimentation pattern obtained with the aqueous 'solution' of the complex. The sedimentation constant ($s_{20,w}$) was found to be approximately 630 *S*. Based on this figure, and again assuming non-hydrated spherical particles with a partial specific volume of 0·75, the particle weight was found to be $8 \cdot 3 \times 10^7$. This value is in fair agreement with that estimated above on the basis of the electron-micrographic observations. In view of this agreement we may infer that the aqueous 'solution' of the complex is not a true solution, but a suspension of the particles having the sizes found in the electron micrograph.

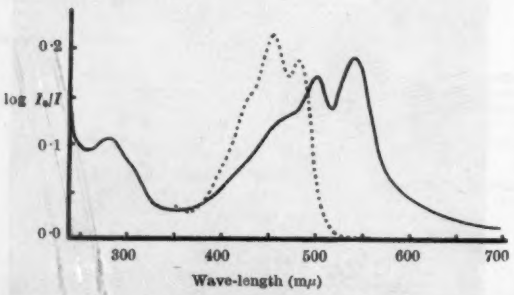

Fig. 2. Comparison of the absorption spectra of the carotene-protein complex dissolved in water (full line) and of the β-carotene separated from it dissolved in *n*-hexane (broken line)

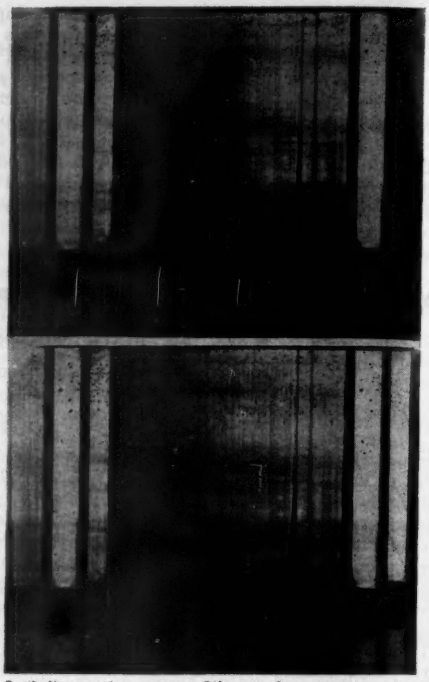

Fig. 3. Sedimentation pattern of the complex; 27,800 *g*; pictures taken at 2-min. intervals

From the estimated value of the particle weight, it is deduced that the mean number of β-carotene molecules attached to each particle is approximately 3×10^3.

It must be emphasized that no reference has been made hitherto to the existence of absorption bands in the absorption spectrum of living green cells corresponding to those of the complex we have isolated. This may be due to the fact that the quantity of the β-carotene existing in the form of the complex is only a minute fraction of the total amount of carotenoids present in green cells. In the case of parsley leaves, the quantity of β-carotene extractable in the form of the complex was only $1 \cdot 73 \times 10^{-3}$ mgm. per gm. dry leaves, whereas the total content of β-carotene was found to be as much as 0·268 mgm. per gm. dry leaves. It seems unlikely that the complex we have obtained was a mere artefact formed during the process of isolation. We believe that the complex represents one of the natural states of β-carotene *in vivo*, playing an active part in the physiology of green leaves.

This work was carried out under the guidance of Prof. H. Tamiya, to whom we are indebted for his interest. We also thank Prof. A. Takamiya and Dr. K. Shibata for advice. Thanks are also due to Mr. T. Samejima for sedimentation measurements, and to the members of the Akashi Manufacturing Company for the electron micrographs. Financial aid from the Ministry of Education is gratefully acknowledged here.

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LETTERS TO THE EDITORS

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Mass-Spectrometric Assay of Elementary Nitrogen

THE method generally used for the estimation of nitrogen-15 in an isotopically enriched organic compound involves the conversion of the organic nitrogen, first to ammonia, and afterwards (by oxidation of the ammonia with alkaline sodium hypobromite) to molecular nitrogen, which is assayed in the mass-spectrometer. Such an assay depends upon the measurement of the intensities of the peaks at mass numbers 28 and 29 due to the ionic species $^{14}N^{14}N^+$ and $^{14}N^{15}N^+$, respectively. Other substances, which can give rise to ions having similar mass/charge ratios, such as acetone (Me_2CO^{++}) and carbon dioxide or carbon monoxide ($^{12}C^{16}O^+$ and $^{13}C^{16}O^+$), will also contribute to the observed intensities of these peaks; and corrections for these have to be applied before the intensities of the peaks can be used for calculating the nitrogen-15 content of the nitrogen sample. A correction is also required to allow for the normal nitrogen introduced by the inclusion of air in the gas sample. The accuracy of the determination of nitrogen-15 therefore depends upon the elimination of contaminants so far as possible, and upon the application of adequate corrections for those contaminants which cannot be removed.

The procedure for the preparation of nitrogen samples has been described in detail by Rittenberg[1], who assumes the principal contaminants to be carbon dioxide, from carbonate present in the alkaline hypobromite, and air. The presence of air in the sample is indicated by peaks at mass numbers 32 ($^{16}O^{16}O^+$) and 40 (A+), and the former, because of its greater intensity, has been used for calculating the correction to be applied for the contribution of normal atmospheric nitrogen. The existence of a peak at mass number 40 seems to have been taken as confirmation that *all* the oxygen in the sample was of atmospheric origin. However, using Rittenberg's procedure for the preparation of nitrogen samples, we found that in most cases the argon peak, at mass 40, was much too small to justify this assumption. The ratio of the intensities of the peaks at mass numbers 32 and 40, for a sample of air in the mass-spectrometer, was 13 : 1. Table 1 presents results showing that the relative intensities of these peaks in the nitrogen samples analysed was much greater than this.

The value of the ratio of the intensities of the 32 and 40 peaks seems to be influenced by the history of the alkaline hypobromite used in the oxidation of the ammonia to elementary nitrogen. When this material was new, that is, less than one week old, and had been stored at 0° C., the ratio of the peaks at mass numbers 32 and 40 was 100–200; whereas, when the hypobromite, though new, had been allowed to stand at room temperature for 12 hr., before storage at 0°, the ratio of the peaks was only 20–60. Small bubbles of gas were generated in the body of the liquid while the hypobromite stood at room temperature. It seems from these results that some free oxygen is formed during the reaction of ammonia with the alkaline hypobromite, and hence it will be more accurate to correct the peaks at mass numbers 28 and 29 for the presence of normal atmospheric nitrogen using the peak at mass 40, due to argon.

The correction for the contribution of $^{12}C^{16}O^+$ and $^{13}C^{16}O^+$ from carbon dioxide has been calculated (Rittenberg[1]) from the intensity of the peak at mass number 44, assuming this to be due to $^{12}C^{16}O^{16}O^+$. It would therefore be expected that the ratio of the intensities of the peaks at mass numbers 44 and 45 would be constant, indicative of the relative abundance of the two carbon isotopes ^{13}C and ^{12}C. It has been observed, however, that the ratio of the intensities of the peaks at mass numbers 44 and 45 is approximately equal to that of the peaks at mass numbers 28 and 29. This is more readily explained if nitrous oxide (as $^{14}N^{14}N^{16}O^+$ and $^{14}N^{15}N^{16}O^+$) and not carbon dioxide is responsible for the peaks at mass numbers 44 and 45. Clusius and Rechnitz[2] have already reported the production of nitrous oxide by the interaction of alkaline hypobromite and ammonium salts, and the results presented here confirm this. Again, the newer samples of hypobromite were found to be the more vigorous oxidants, producing larger peaks at mass numbers 44 and 45. In all the gas samples, nitrous oxide seemed to account for much the largest part of the mass 44 peak. Hence there seems to be no reason to correct for the carbon

Table 1

Source of nitrogen sample	Observed intensities of peaks						Ratio of peak intensities	
	Mass 28	Mass 29	Mass 32	Mass 40	Mass 44	Mass 45	Mass 28 / Mass 29	Mass 44 / Mass 45
Normal ammonium chloride	91·77	0·658	0·065	0·003	0·224	0·002	139·0	112·0
	54·74	0·391	0·123	0·004	1·512	0·010	139·5	151·2
	41·54	0·299	0·093	0·004	1·164	0·010	139·0	116·4
	83·75	0·600	0·179	0·004	0·477	0·004	139·5	119·2
	57·55	0·413	0·123	0·002	0·330	0 002	139·0	165·0
Amino-acids containing about 2 per cent of ^{15}N	85·47	3·107	0·128	—	0·342	0·013	27·5	26·3
	52·79	2·194	0·090	—	3·339	0·136	24·0	24·2
	54·89	2·282	0·095	—	3·447	0·145	24·0	23·8
	62·42	2·599	0·103	0·002	3·902	0·160	24·1	24·3
	45·22	1·879	0·074	0·003	2·834	0·120	24·1	23·6
Amino-acids containing 15 per cent of ^{15}N	85·36	29·62	0·727	0·004	1·130	0·376	2·88	3·01
	61·21	21·25	0·530	0·002	0·798	0·270	2·88	2·95
	39·12	13·65	0·341	0·001	0·502	0·170	2·87	2·92
	39·84	13·98	0·595	0·001	0·998	0·347	2·86	2·88
	79·85	27·85	0·283	0·021	0·520	0·180	2·87	2·89
Ammonium chloride containing 15 per cent of ^{15}N	72·22	63·79	0·082	—	0·169	0·111	1·13	1·52

dioxide in the gas sample, since so little is present when the normal precautions are taken to exclude carbonate from the alkaline hypobromite solution; and the correction factor is small anyway. The presence of nitrous oxide in the gas sample is of interest in accounting for the appearance of a peak at mass number 30, which is much larger than would be expected from the $^{15}N^{15}N+$ contribution. In the mass-spectrometer, the rupture of nitrous oxide gives $NO+$, rather than N_2+, and this completely masks the contribution of the $^{15}N^{15}N+$ to the peak at mass number 30, even when the ^{15}N content of the nitrogen sample is quite large (15–18 atoms per cent).

The nitrous oxide may be eliminated, if it is so desired, by placing a liquid-air trap between the generator and the gas sample tube. However, there does not seem to be any way of avoiding the production of free oxygen during the preparation of the nitrogen sample. The small intensity of the peak at mass number 40 makes its accurate measurement difficult, and where the intensities of the peaks at mass numbers 32 and 40 correspond, then a correction for air, based on the size of the mass 32 peak, will be more accurate. However, in nearly all the results which we obtained, the use of the mass 40 peak gave a considerably smaller correction than that of the 32 peak, and was presumably more accurate.

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Aerodynamic Drag of Perforated Plates

We have recently conducted wind-tunnel experiments to determine the aerodynamic drag of perforated plates at zero incidence by the wake transverse method. The plates have no protuberances, yet they are aerodynamically rough and give a drag comparable with that of plates covered with protruding roughness of the same size and spacing as the holes.

The non-dimensional quantities which could affect the drag are: (1) the Reynolds number of the chord of the plate; (2) the Reynolds number of the diameter of the holes; (3) the ratio of the area of the holes to the area of the plate; (4) the ratio of hole diameter to plate thickness. During the experiments, the airspeed, plate chord, plate thickness and total area of the holes remained constant, while the hole diameter was varied. Thus ratios (1) and (3) were constant, their values being $3{\cdot}5 \times 10^5$ and 0·355 respectively.

The plates were of a double thickness of 18-gauge perforated plate with the holes coinciding but with a sheet of tissue paper sandwiched between them. The leading edge of each was cut on a line through solid metal and was not sharpened. Therefore, the measured drag included surface drag and form drag due to the frontal area. To assess the latter, the drag coefficient of a smooth plate of the same size and thickness was measured and found to be 0·023, which is more than double the value 0·011 expected for a very thin smooth plate in turbulent flow[1]. The difference, 0·012, may be ascribed to the form drag, and may be subtracted from the drag coefficients of the other plates to obtain that part of the drag due to the surface itself.

Table 1. Drag of Perforated Plates

Reynolds number of tests, $3{\cdot}5 \times 10^5$. Chord of plate, 6¼ in.						
Hole diameter (in.)	Hole diameter/plate thickness	Hole Reynolds No.	Drag coefficient			
			With paper sandwiched		Without paper	
			As measured	Corrected for frontal area	As measured	Corrected for frontal area
No holes	—	—	0·023	0·011	0·023	0·011
0·125	2·27	7×10^3	0·033	0·021	0·071	0·059
1·125	21·6	$6{\cdot}3 \times 10^4$	0·033	0·021	0·038	0·026
4·5	84	$2{\cdot}5 \times 10^5$	0·025	0·013	0·028	0·016

The sandwiching of paper between the plates produces the effect of a flat plate covered with a number of cylindrical pits the depths of which equal the plate thickness. The results are summarized in Table 1, from which it is seen the drag considerably exceeds that of a smooth plate and provides evidence of vigorous interchange between the fluid in the hollows and the passing stream.

Further tests were made at the same Reynolds number, after removing the paper from between the plates, thus allowing turbulent transverse velocity components to transfer momentum deeper into the plates where it could build pressures on more of the forward facing surface of each perforation. From Table 1, it is seen that the drag is now greater than that when the paper is preventing through-flow.

Thus perforations or hollows can give rise to great aerodynamic drag, so that a surface entirely devoid of protrusions may behave as if extremely rough. This property may be useful in the design of energy dissipators.

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High-Efficiency Columns for the Analysis of Hydrocarbons by Gas-Liquid Chromatography

Following the work of Keulemans and Kwantes[1], the factors affecting column efficiency have been examined further, and the conditions required to obtain optimum column-efficiency have been determined. Important factors affecting column efficiency are the correct grade of column support, the quantity of liquid phase on the support and the dimensions of the column. Column efficiencies[2] of 12,000 theoretical plates may be obtained using the following conditions:

Column length	25 ft.
Column diameter	4 mm.
Column temperature	78° C.
Carrier gas	25 per cent nitrogen, 75 per cent hydrogen
Carrier gas flow	37 ml./min.
Column support	Johns–Manville C22 insulating brick
Support grade	60–100 *B.S.* mesh
Liquid phase on support	5 per cent w/w
Column charge	< 400 μgm.

A chromatogram of a synthetic mixture of *n*-pentane, *n*-hexane, *n*-heptane, *n*-octane, methyl*cyclo*pentane, methyl*cyclo*hexane, benzene, toluene, ethylbenzene, *o*-xylene, *m*-xylene and *p*-xylene is shown in Fig. 1. Under these conditions, separation of *m*- and *p*-xylene is shown. Prior to this work, high efficiencies could not be obtained by merely increasing column length. The above conditions are such that column efficiency is approximately a linear function of the column length. Doubling the length of the column results in almost twice the column efficiency.

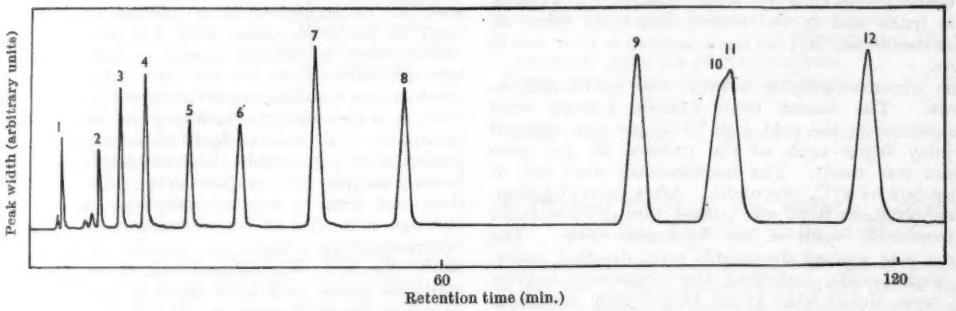

Fig. 1. Chromatogram of a synthetic mixture: (1) *n*-pentane; (2) *n*-hexane; (3) methyl*cyclo*pentane; (4) benzene; (5) *n*-heptane; (6) methyl*cyclo*hexane; (7) toluene; (8) *n*-octane; (9) ethyl benzene; (10) *p*-xylene; (11) *m*-xylene; (12) *o*-xylene

An important factor influencing the efficiency produced by the 12,000 plate column is the total quantity of charge placed on the column. If the charge is greater than 400 μgm., or if more than 80 μgm. of any individual component is present, tailing of the emergent peaks occurs with a resulting fall in column efficiency. An improved form of the hydrogen flame detector[2] was used in this work. Details will be published elsewhere.

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Electric Strength of Unsaturated Hydrocarbon Gases

Previous work[1] has indicated that a larger number of gaseous hydrocarbons should be studied before a comprehensive theory of the influence of molecular structure on electric breakdown can be advanced.

The paraffin series has been extended by *Vs-pd* measurements[2] in *n*-pentane and *n*-hexane and their cyclo-derivatives together with *n*-octane, whereas hexene-1 and isoprene are added to the mon- and di-olefin series respectively.

Using the simple Devins and Crowe[3] picture, the following relative composite cross-sections are determined:

θ_{C-H}	θ_{C-C}	$\theta_{C=C}$	$\theta_{C\equiv C}$
1·0	0·85 1·0 (cyclo-compounds)	8·5 (mon-olefins) 9·4 (di-olefins)	10·5

Contrary to other published results[4], the carbon–carbon single bond is found not to be zero, but of the same order of magnitude as the carbon–hydrogen single bond. This discrepancy can be attributed to the elimination of space charge effects and the extended measurements both as regards the number and variety of hydrocarbons investigated and the *pd* range over which each member was tested; where necessary, *Vs-pd* measurements were carried out at an elevated temperature. This makes the present interpretation more reliable. For example, Crowe and Devins[4] make no reference to their earlier reported breakdown measurements[3], which differ by as much as 20 per cent and are in general agreement with previous work[1].

Except for small pulse activity due to the electronic excitation-levels being non-dissociative[5], no anomalous[4] result was obtained for the cyclo-paraffins, and as to be expected, the *Vs-pd* characteristic of *cyclo*-hexane exceeded that of *cyclo*-pentane by a comfortable margin over the entire *pd* range.

The effect of alkyl substitution around the carbon–carbon double bond has been further investigated by *Vs-pd* measurements in *iso*-butene, *cis*- and *trans*-butene, trimethylethylene and *cyclo*-pentene.

Correlation between breakdown measurements and ultra-violet spectra for these compounds, one of the aims of this work, is good. For example, *cis*-butene 2 and *cyclo*-pentene yielded the same *Vs-pd* characteristic whereas a differing characteristic was obtained for *cis*- and *trans*-butene 2, in agreement with ultra-violet work.

More complete reports, one of them in collaboration with T. J. Lewis, will be published elsewhere.

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Occurrence of Gamma-Guanidinobutyric Acid

In the course of studies on soluble nitrogenous extractives from various sources using paper chromatography, γ-guanidinobutyric acid was found to be rather widely distributed in Nature. Using paper chromatography, we have identified this guanidine compound in some insects, in various edible fruits and in the tissues and body fluids of higher mammals, and we have isolated it from cattle brains.

The chromatographic survey was performed as follows. The tissues from various sources were homogenized in the cold with 70–75 per cent ethanol (in juicy fruits such as the melons, 95 per cent ethanol was used). The homogenates were left in the ice-box at 4° C. overnight. After centrifugation, the supernatant fluid was passed through a column of 'Dowex-50' resin in the hydrogen cycle. The column was washed thoroughly with distilled water. The amino-acids, including the γ-guanidinobutyric acid, were eluted with about 14 per cent ammonia. The eluate was lyophilized after removal of ammonia under vacuum at 25°. The solids were dissolved in a minimum amount of water and used for identification purposes. Preliminary testing for the presence of γ-guanidinobutyric acid was carried out using one-dimensional paper chromatography and *t*-butyl alcohol/formic acid/water (70 : 15 : 15) as solvent. When a positive Sakaguchi test was obtained, two-dimensional chromatograms[1,2] of the unknown were run with and without added authentic γ-guanidinobutyric acid. Additional evidence for the identity of the compound was obtained with material eluted by water from strips of one-dimensional chromatograms. The eluted material was degraded with barium hydroxide to yield γ-aminobutyric acid according to the method of Rivard and Carter[3] for the conversion of arginine to ornithine. The chromatographic characteristics of the natural compounds as well as their R_F and R(β-alanine) values were then determined.

Isolation of γ-guanidinobutyric acid. A preliminary experiment for the isolation of this compound was attempted on a small scale. A 70 per cent ethanol extract of 1·5 kgm. of cattle brains was prepared. The amino-acids as well as guanidine compounds of the extract were adsorbed on a 'Dowex-50' resin in the hydrogen cycle and eluted with ammonia. The eluate, after removal of ammonia under vacuum, was lyophilized. The dried material was used for paper chromatography or for the fractionation of γ-guanidinobutyric acid as follows. A solution of the dried material was first fractionated in a column of 'Dowex-1' resin in the hydroxyl cycle. Distilled water was used as eluting agent and the fraction containing the γ-guanidinobutyric acid was collected and chromatographed in a column of 'Dowex-50' resin in the acid cycle, with 1 *N* and 2 *N* hydrochloric acid as eluting agents. After several recrystallizations from 50 per cent ethanol, the final product was insufficient for elemental analysis. However, it is chromatographically pure, and further, on treatment with barium hydroxide, it yields a compound indistinguishable chromatographically from a known sample of γ-aminobutyric acid. The latter does not form a copper complex, since it moves through a barrier of copper carbonate[4] on a paper chromatogram. Both the natural acids give the same R_F and R(β-alanine) values as the known synthetic acids, and both have the same mobilities in paper electrophoresis at *p*H 8·6 as the respective synthetic acids (Table 2).

Table 1. Occurrence of γ-Guanidinobutyric Acid in Various Sources

Source tested	Amount (μgm./gm. wet weight)
Fruits:	
Banana (*Musa sapientum*)	5–10
Bitter melon (*Momordica charantia* L.)	0
Cantaloupe (*Cucumis melo*)	1–5
Date (*Phoenix dactylifera*)	10–20
Honeydew melon (*Cucumis melo*)	0
Mango (*Mangifera india*)	2–10
Papaya (*Carica papaya*)	1–5
Persian melon (*Cucumis melo*)	1–5
Strawberry (*Fragaria chiloensis*)	1–5
Watermelon (*Cucumis melo*)	2–10
Insects:	
Aedes aegypti—Tissue	10–20
Excreta	(10–20 μgm./mgm. N)
Culex pipiens—Excreta	(5–15 μgm./mgm. N)
Anopheles quadrimaculatus—Excreta	(5–20 μgm./mgm. N)
Silkworm pupæ (*Bombyx mori*)—Tissue	10–20
Vertebrates:	
Dog—Brain	≃ 8
Kidney	5–10
Liver	1—5
Urines	+
Cattle—Brains	≃ 5
Human—Brains	5–10
Some urines	(1–20 mgm./day)

Table 1 gives the distribution and occurrence of the guanidine compound in various sources. The values are only approximations. They were obtained by visual comparison of chromatograms of the unknown and known γ-guanidinobutyric acid. In certain cases, paper electrophoresis of the unknown and known were also used.

Gamma-guanidinobutyric acid was first isolated by Kutscher[5] among the oxidation products of arginine. Later, studies in marine invertebrates indicated that γ-guanidinobutyric acid arises from arginine by the action of an L-amino-acid oxidase and subsequent oxidative decarboxylation[6]. It has recently been found by J. Pisano and associates (personal communication) that γ-guanidinobutyric acid could be formed by a transamidination reaction in the kidney between arginine as a donor and γ-aminobutyric acid as the acceptor of the amidine moiety. Recent studies by Walker[7] have shown that mammalian kidney carries out transamidination reactions such

Table 2. R_F and R (β-alanine) Values of Natural and Synthetic γ-Guanidinobutyric Acid, Natural and Synthetic γ-Amino-butyric Acid

	R_F		R(β-alanine)	
	Solvent *A*	Solvent *B*	Solvent *A*	Solvent *B*
γ-Guanidinobutyric acid (natural)	0·65	0·11	1·54	1·67
γ-Guanidinobutyric acid (synthetic)	0·65	0·11	1·49	1·64
γ-Aminobutyric acid (natural)	0·52	0·05	1·18	1·16
γ-Aminobutyric acid (synthetic)	0·52	0·05	1·17	1·12

Solvent *A*: *t*-Butyl alcohol/formic acid/water (70 : 15 : 15).
Solvent *B*: *t*-Amyl alcohol/2,4-lutidine/water (178 : 178 : 110).

that any donor (for example, canavanine, arginine or guanidinoacetate) could transfer its amidine group to any acceptor (for example, ornithine, canaline, glycine or hydroxylamine). It was shown by Kobayashi[8] that γ-guanidinobutyric acid was degraded to γ-aminobutyric acid by a 'heteroarginase' from an extract of rabbit intestine mucous membrane. The latter compound could also arise from glutamic acid by the action of a decarboxylase[9].

Recent findings of Bazemore *et al.*[10] indicated that γ-aminobutyric acid has a neurophysiological activity. The existence of the γ-guanidino analogue in vertebrates as reported here, and the interconvertibility of these two butyric acids into each other in enzymatic reactions, suggest that both compounds may well be playing a part in some nervous processes.

The substance of this communication was presented at the 131st National Meeting of the American Chemical Society, Miami, Florida, 1957, and a detailed account is being prepared.

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Conical Paper Chromatography

A circular filter paper suitable for partition paper chromatography is cut so that it can be made into a cone. A number of origins are marked at adequate intervals near the lower edge, the standard and unknown solutions are dropped on these origins (see Fig. 1) and chromatographic development allowed to take place in an upward direction. The cone is immersed in the solvent in a Petri dish placed in a glass vessel with a tight lid (see Fig. 2).

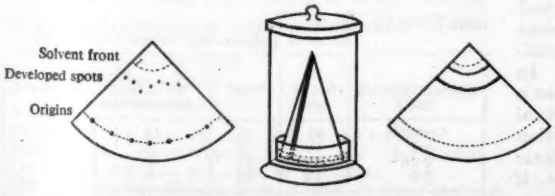

Fig. 1 Fig. 2 Fig. 3

If a continuous line of test solution is applied and then the development is performed, the resulting chromatogram will appear as a series of arcs (see Fig. 3). This latter procedure is especially useful in preparatory chromatography, since the arc required can be readily chosen and cut off.

Particular advantages of this method are that special apparatus is not required; a comparatively smaller size of filter paper and less solvent are required than some of the methods generally used. The development of many materials simultaneously is possible on one chromatogram; the zones are concentrated, so that dilute solutions which would not be sufficiently strong for conventional methods of paper chromatography can be chromatographed by this method. The method can be particularly useful in preparative chromatography.

Using this method of conical paper chromatography, I have been able to identify the green pigment of the Indian lotus embryo with chlorophylls *a* and *b*. The same solvent as that of Chiba and Noguchi[1] was used for the development of this pigment.

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A Diurnal Cycle in the Mitotic Activity of Ascites Tumour Cells in Mice

Observations of a diurnal variation of frequency of mitosis in the normal tissues of the mouse show a diphasic rhythm in the skin epidermis and epithelia of œsophagus, epididymis and duodenal mucosa[1]. On the other hand, absence of a diurnal variation was noted in lymph nodes of the gut and in the semen-producing canals of the testis[1].

A double diurnal cycle in the mitotic activity of different kinds of neoplastic tissue has also been reported for human carcinoma[2] as well as for *ITB*-tumours in rats[2]. The ascites tumour represents a certain type of tumour—a cell suspension implanted in a host animal; thus there is a looser connexion both between the tumour cells themselves and between the tumour and the host animal. For natural reasons the vascularization in ascites tumours also differs from that in solid tumours. It seemed, therefore, of interest to determine whether a mitotic daily rhythm exists also in ascites tumour cells.

As experimental animals we used male white mice, two to three months old and in good health. They were kept under standard conditions in normal daylight, at a constant temperature of + 18° C., and were fed every day at 9–10 a.m. After an adaptation period of at least two weeks under these conditions, the mice were inoculated intraperitoneally with ascites tumour cells of the Ehrlich type. Since we thought that puncturing the belly too frequently for obtaining samples disturbed the daily rhythm of the mice, we started a series of experiments during May 1955 in which samples of ascites cells were taken only twice a day. One sample was taken at an hour which was shifted continuously 3 hr. forward from one day to the next. Another sample was always taken at the same hour every day. The differences in value between these two samples were

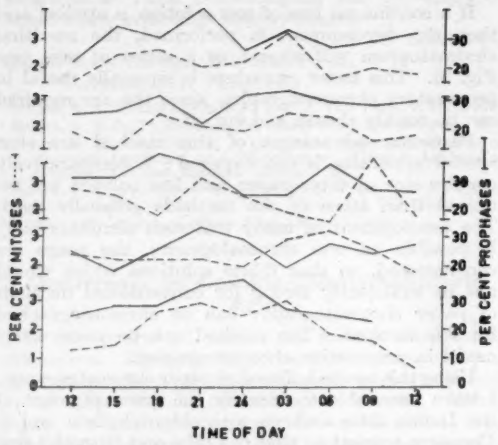

Fig. 1. Daily rhythm in mitotic activity of ascites tumour cells in five mice. Continuous line: prophases (per cent). Broken line: mitoses (per cent)

used as a sequence to give an expression of the daily variation in the mitotic frequency of the tumour cells. The samples taken at a fixed hour showed the ageing of the tumour and demonstrated a maximum in mitotic frequency at 7–10 days incubation. On the same occasions samples of the ear epithelium were taken with the conchotome for comparison. However, in spite of the fact that four series of five mice each were used, the results obtained were not sufficiently uniform. The principal reason for the irregularity of the values must be the fact that a daily rhythm is not firmly fixed to definite hours of the day.

As these series of experiments failed to give conclusive results concerning a possible mitotic rhythm, we tried the other type of experiment taking samples frequently during 24 hr. Surprisingly enough, this treatment did not disturb the daily rhythm. Five male white mice, kept as described above, were used for the experiment. The mice were inoculated on October 25, 1955, and the samples were taken during the twenty-four hours of November 2. Samples were drawn every third hour, fixed and stained by aceto-orcein and examined microscopically as squash preparations, and the mitotic index as well as the amount of different mitotic phases were determined. Every count included 1,000 cells. The results are presented in Fig. 1.

Of the five mice used, the ascites tumour in four of them showed a diphasic mitotic rhythm, with one maximum in the early night and another in the early morning. One mouse showed a single maximum in mitotic frequency—during the night only. In the experimental series with the long-period sampling, only a night maximum could be demonstrated with any certainty for both the ascites cells and the ear epithelia. It may be questioned whether the observed maxima of mitotic frequency actually represent maxima in mitotic activity, when there is no possibility of counting a change in the cell numbers. In such a case it is almost impossible to state whether a maximum in mitotic frequency is the result of actual increased production of cells or of a mitotic inhibition —a prolongation of the time taken by the mitotic stages in relation to the interphase. However, if mitotic maxima coincide with a maximum of prophases, there is a strong indication that cells have been forced out of the interphase stage into the mitotic stage, and thus the mitotic maximum corresponds to an increased true mitotic activity. As can be seen from Fig. 1, the maxima in mitotic frequency coincide in all cases with prophase maxima. Thus it may be concluded that an ascites tumour has a diurnal cycle of true mitotic activity, which is in most cases diphasic. This may correspond to the double diurnal cycle reported for the majority of solid tissues of the mouse, provided that these maxima also represent an increase of cell production.

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Teratogenic Effects of Beta-Amino-Propionitrile in the Chick Embryo

The present investigation was undertaken in order to study the possible effects of β-aminopropionitrile on early fœtal development.

Stamler[1] has shown that the feeding of sweet-pea seed meal to pregnant rats during the last six days of gestation induced poor development of mesodermal tissues and fœtal death, whereas the fœtus was not adversely affected if the meal was withdrawn from the diet before the seventeenth day of gestation. These findings have been attributed to changes either in the activity of fœtal mesenchymal tissues, or in placental permeability[1], or in maternal endocrine balance[2]. Thus it seemed necessary to exclude maternal-fœtal interrelations in order to assess the possible effects of β-aminopropionitrile. The chick embryo was therefore chosen as the test organism.

Batches of cross-bred (Rhode Island Red and Leghorn) fertile eggs were treated at different times up to the ninth day of incubation. A single injection of β-aminopropionitrile (0·25 per cent, w/v aqueous solution), varying in volume from 0·05 ml. to 0·4 ml., was made into the yolk sac of each egg. Batches of control eggs were similarly injected with identical volumes of distilled water. Embryos were examined on the tenth, eleventh or twelfth days of incubation.

The results following injections made on the seventh day of incubation are shown in Table 1.

Of the twenty-six surviving embryos in the experimental group, twenty-one were abnormal (Table 1), several abnormalities frequently being present in a single embryo. In all the malformed embryos both tibiæ were bowed, while the mandibles were markedly buckled or bowed in fourteen (Fig. 1). The metatarsus was bowed in one embryo, hæmothorax was

Table 1. β-Aminopropionitrile (0·25 per cent) injected on the Seventh Day of Incubation

Amount injected (ml.)	No. of eggs	Died	Survived	
			No obvious abnormalities	Malformed
Controls	24	9	14	1
0·1	18	5	5	7
0·15	35	24	0	11
0·2	16	13	0	3
Totals	69	42	5	21

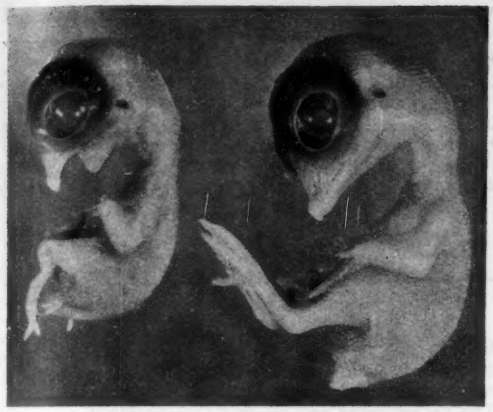

Fig. 1. Left: Ten-day old embryo with stunting, buckling of mandible and bowing of tibiæ induced by 0·15 ml. of 0·25 per cent β-aminopropionitrile injected into the yolk on the seventh day of incubation. Right: Control ten-day old embryo for comparison

found in another, and in a third there was scoliosis of the cervical vertebræ. Œdema of the body wall alone was found in the only abnormal control embryo. It was possible to examine only eight of the embryos that had died—the remainder being far too macerated. All these embryos showed malformed beaks, the majority had hæmorrhages into the amniotic sac and/or hæmorrhages from the vessels of the chorio-allantois.

Embryos dosed with β-aminopropionitrile on the first four days of incubation showed the same abnormalities as those injected on the seventh day, but in addition three had agenesis of the anterior thoracic and abdominal walls.

The pronounced changes in the beaks of chick embryos may perhaps be the counterpart of the mandibular exostoses described in rats poisoned with β-aminopropionitrile[3]. Agenesis of the body-wall in chicks, on the other hand, may perhaps be compared with the abdominal herniæ described in rats on lathyrogenic diets[4].

It is clear, even from the above macroscopic studies, that as in the rat so too in the chick, the mesenchymal tissues are profoundly affected by β-aminopropionitrile. The serial events culminating in the lesions described above require microscopic investigation. So also does the possible existence of lesions in the internal organs and vessels, particularly as studies in weanling rats have shown the aorta to be extremely susceptible to the effects of β-aminopropionitrile.

These investigations are now in progress.

I thank Prof. T. Gillman for his encouragement and advice during this investigation, and Mrs. P. McManus for her skilled technical assistance. This work was carried out with the aid of a grant from the National Cancer Association of South Africa.

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Sodium Ions and Tissue Metabolism: Some Metabolic Peculiarities of Brain Tissue

ACCORDING to Hodgkin and Katz[1], in the complete absence of sodium ions from the surrounding medium, the action potential of the giant axon of the squid is diminished, whereas its resting potential is not changed at all. This observation of the effect of sodium ions on the electrical activity of nerve fibre is one of the bases of the sodium theory of nerve activity of the Cambridge school. So the metabolic effect of sodium-free medium on brain slices has been studied[2], with special emphasis on its relation to the functioning of nerve cells in general, because the metabolic activity of nerve fibres is difficult to measure.

We have studied the effect of sodium-free medium on the metabolism of various tissues, with special attention to the metabolic peculiarities of brain tissue, and also the relation between metabolism and sodium concentration.

The experimental conditions have previously been described in detail[2]. In preparing sodium-free medium, sodium phosphate was replaced with potassium phosphate, and sodium chloride with choline chloride in order to maintain the correct osmotic pressure. In the experiments summarized in Fig. 1, sodium chloride in the usual Krebs–phosphate Ringer solution was replaced partially with potassium chloride, and for the complete omission of sodium ions glycyl-glycine buffer was used instead of sodium phosphate buffer. Glucose was determined by the 'anthrone' method, pyruvic acid according to Friedemann and Haugen and lactic acid by the method of Barker and Summerson.

On the complete omission of sodium ions from the incubation medium, the aerobic lactic acid formation of guinea pig brain cortex slices was greatly increased and also the glucose consumption increased. But the oxygen uptake was not altered significantly. The aerobic formation of lactic acid from fructose

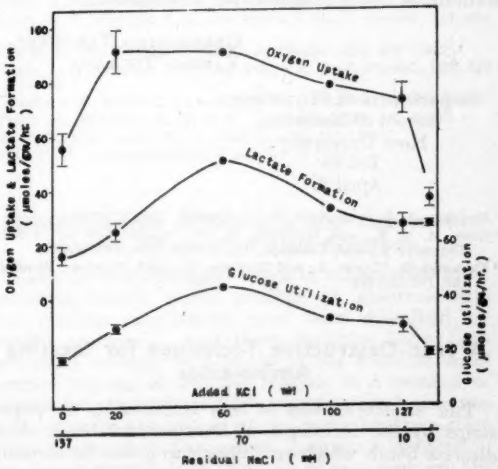

Fig. 1. Metabolism of brain slices and sodium concentration. Guinea pig brain cortex slices were used. Substrate, glucose (3·3 m*M*); incubation, 37° C.; gas phase, pure oxygen; mean ± standard deviation of five experiments is shown; points without short bars indicate the mean of two experiments

Table 1. Effect of Sodium-free Medium on the Metabolism of Slices in the Presence of Glucose or Pyruvate as a Substrate

Animal and tissue	Glucose as a substrate (3·3 m*M*)						Pyruvate as a substrate (6·0 m*M*)	
	Oxygen uptake (μmol./gm./hr.)		Lactate formation (μmol./gm./hr.)		Glucose utilization (μmol./gm./hr.)		Oxygen uptake (μmol./gm./hr.)	
	Control	Sodium-free	Control	Sodium-free	Control	Sodium-free	Control	Sodium-free
Guinea pig brain cortex	55·9 ± 6·0* (10)	58·9 ± 11·7 (6)	16·6 ± 3·2 (10)	48·8 ± 10·4 (6)	17·7 ± 1·4 (10)	36·7 ± 5·4 (6)	54·9 ± 4·2 (8)	93·3 ± 5·2 (5)
Guinea pig liver	34·0 ± 3·4 (3)	32·5 (2)	< 2·0	< 2·0	—†	—	46·1 ± 1·7 (3)	40·0 (2)
Rat diaphragm	54·8 ± 7·8 (4)	28·7 ± 4·3 (4)	9·51 ± 0·88 (4)	8·32 ± 1·21 (4)	5·86 ± 1·44 (4)	3·68 ± 2·31 (4)	63·9 ± 11·4 (3)	35·8 ± 7·2 (4)
Rabbit kidney cortex	80·0 (2)	50·3 ± 1·5 (3)	15·8 (2)	8·18 ± 0·08 (3)	11·7 (2)	6·44 ± 0·34 (3)	94·9 (2)	68·6 ± 2·9 (3)

* Mean ± standard deviation: figures in parentheses, numbers of experiments. † Glucose was rather increased in the medium.

was also increased to 34·3 ± 0·5 (3) μmol./gm./hr. in the sodium-free medium, the control value of which was only 6·2 ± 0·4 (3) μmol./gm./hr. When lactic acid was used as a substrate, the respiration was severely inhibited and the utilization of lactic acid was not detected. On the other hand, when pyruvic acid was added as a substrate, the oxygen uptake was increased greatly. But the respiration of brain slices metabolizing citrate, succinate, fumarate or glutamate was somewhat inhibited. These effects of sodium-free medium on the metabolism are thought to be peculiar to brain tissue, and are not observed with slices of liver, kidney or diaphragm (Table 1).

When potassium ions were added to the medium, replacing sodium, the oxygen uptake, glucose utilization and lactic acid formation were highest on the addition of 60 m.moles potassium; with further decrease of sodium ions, the metabolism was somewhat reduced. It was found that the ratio of the concentration of potassium to sodium is intimately related to the metabolic activity of brain slices.

These phenomena indicate some metabolic characteristics of brain tissue and the functional specificities of nerve cells. A detailed report on the effect of some inorganic ions, including others beside sodium, is being prepared for publication.

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A Non-Destructive Technique for locating Amino-acids

The electrophoresis of free amino-acids on paper strips by the technique of Durrum[1] results in close discrete bands which are difficult to locate by running parallel pilot substances.

The fluorescence produced by heating the paper at 100° C. for 15 min.[2] proved to be too insensitive for satisfatory location. Heating after immersion in acetone increases the sensitivity, but we have now found that treating amino- or imino-acids with *o*-coumaric acid dissolved in acetone produces a compound which gives a bright yellow fluorescence. The amino-acids can easily be regenerated quantitatively.

Following electrophoresis in 2 *N* acetic acid, the paper strips are dried overnight at room temperature, and then immersed in acetone containing 0·1 per cent *o*-coumaric acid. The lengths of paper are air dried for 2–3 min., warmed in an oven at 100° C. for 1–2 min., and then briefly exposed to ultra-violet light from a Mazda *MBW/U* bulb. The yellow fluorescent amino-acid complex can then be accurately delineated against a background blue fluorescence which rapidly fades due to the heat produced by the ultra-violet lamp. Finger pressure also produces yellow fluorescent areas.

The separate bands of amino-acids can be extracted and then chromatographed by the descending butanol/acetic acid/water (40–10–50) system. The *o*-coumaric acid contamination runs with the solvent front and has no effect upon either the speed of running or upon the separation of the eighteen common amino-acids investigated. After chromatography, the paper sheets are dried overnight at room temperature, and the individual amino-acids located by the fluorescence technique. Under these conditions the sensitivity is such that 2 μgm. of amino-acid/sq. cm. of paper can be detected without difficulty; the lower limit appears to be about 1·2–1·4 μgm./sq. cm. The area of paper containing the amino-acid is cut out and the amino-acid content determined by the pyridine–phenol–ninhydrin method of Troll and Cannan[3].

The excised paper contains less than 30 μgm. of *o*-coumaric acid per sq. cm., and experiments have shown that the colorimetric determination is unaffected by the presence of 300 μgm. of *o*-coumaric acid. Recovery experiments employing the method of location described have given quantitative yields of chromatographed amino-acids, but extending the time of heating at 100° C. to 5 min. will produce losses of up to 10 per cent. For this reason overexposure to the hot ultra-violet lamp should be avoided.

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A Route for Intravenous Injection in the Albino Rat

Drs. Everett and Sawyer[1] claim to have found that the small saphenous vein on the foot of the rat is far more satisfactory than the more commonly used tail vein for intravenous injection.

We, in this laboratory, found even this vessel in the albino rat (200 gm.) to be too small and difficult to use, and have developed the following site and technique to our greater satisfaction; this, also, is on the unanæsthetized rat.

The rat is placed quickly and comfortably into the animal restrainer[2], leaving one hind-limb free (30–40 sec.). The long hairs are then removed from ankle to hip on the posterior surface of the free limb, using electric clippers (10–15 sec.), then wet-shaved (about 30 sec.) to expose the quite large superficial vein—the lateral marginal vein[3].

The rat can be held firmly by an assistant placing the right hand over the hips of the animal, with the free limb passing between the first and second fingers and applying sufficient pressure to cause this vein to become quite prominent without the use of any form of tourniquet. The assistant's left hand holds the foot firmly.

A 27-gauge, ½-in. hypodermic needle is suitable for this vein, though some operators may prefer a 26-gauge.

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Intracellular Recording from Spinal Motoneurones following Stimulation of Medullary Pyramids

ALTHOUGH a rich literature is available concerning the anatomy and the physiology of the lateral corticospinal tract, no reports have been published in which intracellular electrodes were employed in studying the synaptic connexions of the corticospinal tract in the lumbar spinal cord. Lloyd[1] used extracellular and ventral root recording, and laid the theoretical groundwork for the present study.

I have now shown that motoneurones are excited by corticospinal impulses in the same manner as that in which they are excited by afferent (orthodromic), antidromic or direct routes of stimulation[2–7].

Glass micropipettes filled with potassium chloride were inserted into cat spinal interneurones and motoneurones, identified according to criteria established by Eccles[8] and Frank and Fuortes[4]. The potentials led off from these cells were amplified and recorded using the technique of Frank and Fuortes[4] in one case and that of Li and Jasper[9] in all the other experiments. Stimulation of medullary pyramids was accomplished by direct insertion of electrodes (platinum or steel, insulated to tip) following ventral neck dissection. All animals were decerebrate. Contralateral limb movement was used for identifying the position of the stimulating pair with respect to the decussation of the pyramids.

The pyramidal tract stimulus (isolated by radio-frequency) consisted in a train of seven to ten square pulses of amplitude 7·5–10·0 V., duration 0·1 msec., at 1·0 msec. intervals. Such trains summated with potentials recorded from a motor neurone in response to dorsal root stimulation, or antidromic stimuli of insufficient intensity to invade the soma, to produce firing of motoneurones. Non-invading spikes following maximal ventral root stimulation were helped to invade the soma by pyramidal stimulation. Small responses to the second of two antidromic shocks within critical stimulus interval[4] were also helped to invade by the pyramidal stimulus. Pyramidal stimulation alone produced graded subthreshold depolarization resembling dorsal root synaptic potential, although shorter in duration. Progressive increase in the strength and/or frequency of such stimulation resulted in the firing of motoneurones. The latency, amplitude and duration of the responses were similar to those obtained by other means. All responses exhibited inflexions in the rising phase of the spike, a finding which presupposes the mode of excitation of the motoneurone by corticospinal impulses to be the same as that found for other routes by other authors[2,7,9].

Thus far in the study, eight interneurones have been penetrated, and the activity of five of them following physiological stimulation (toe-pad pinch) was increased by pyramidal stimulation, while three were inhibited. The patterns of response of the interneurones fell roughly into two groups which will be described elsewhere at length. The implications of these results with respect to corticospinal control of movement will also be discussed elsewhere.

Thanks are due to Drs. Karl Frank, Choh-luh Li, Cosimo Ajmone-Marsan, and Messrs. Saxton Howard and Samuel Cooper for their help in various phases of this investigation.

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Differentiation of Somatic and Autonomic Nerve Fibres in Tissue Sections

VARIOUS morphological types of encapsulated and non-encapsulated nerve endings in glabrous skin and mucous membranes have been described by several workers[1,2], and these findings have been confirmed recently in a study of the innervation of selected regions of the oral mucosa in a number of mammals[3]. In contrast, little attention has been given in the past to the nature of the nerve plexuses from which these terminations arise, and the investigation has been extended to include this aspect of the problem[4].

Although the topographical features of the plexuses can be demonstrated satisfactorily using routine neurohistological methods, such as methylene blue

and silver impregnation techniques, considerable difficulty has been experienced in distinguishing somatic myelinated fibres from those pertaining to the autonomic nervous system. This can be attributed to the inconsistent results normally obtained by these methods; for in silver impregnation of frozen sections, for example, while one section may show optimal staining for both the axons and the myelin sheaths, succeeding sections may stain quite differently and the distinction between the myelinated and non-myelinated nerve fibres is lost. One is prevented, therefore, from tracing these fibres for other than a short distance in the tissues, and from differentiating between finer branchings of myelinated fibres and those of the autonomic system. In addition, results are governed to some extent by the appearance of artefacts, which even when reduced to a minimum can by no means be discounted. It is thus extremely difficult to establish a set of criteria applicable to all sections in a series.

In an attempt to stain autonomic fibres constantly and selectively a method, first described by Champy[5] to demonstrate sympathetic terminations in or around cellular elements, has been tried with interesting results. It has been claimed[6] that the method is specific for sympathetic endings by reason of their association with adrenalin-like substances, and the technique applied to the innervation of the intestinal tract and various glandular structures, notably the salivary glands[7].

In oral mucous membrane, however, not only are postganglionic autonomic fibres demonstrated as a succession of tiny black beads or fine lines, but also myelinated somatic fibres show in marked contrast well-defined myelin sheaths with nodes of Ranvier. The fibre bundles of which the plexuses are composed are seen to consist of a mixture of both types of nerve fibre, and the perivascular plexuses and terminal nervous network are easily made out. Neither is there confusion between the latter and the fine ultra-terminal branches of the somatic fibres, for these do not appear to stain by this method. The nature of the differentially stained fibres has been confirmed by experiments on animals, preliminary results indicating an extensive anastomosis of the terminal autonomic network across the mid-line, a feature which is being investigated more fully.

In the present work the original staining solution formula has been employed, namely, a block of fresh tissue is immersed in a mixture of osmium tetroxide and sodium iodide for 24 hr. Thereafter instead of embedding in paraffin, as recommended[5], the tissue is washed well in running tap water and stored for several days in 10 per cent neutral formalin before preparing frozen sections. The additional fixation has been found to limit the diffusion of the contents of fat cells, which are heavily stained by the osmic acid, and this limitation is further aided by the use of frozen sections. During mounting the period in xylol is reduced to a minimum, and although some diffusion may persist, it is not sufficient to detract from the clarity of detail, either for microscopic examination or photographic reproduction. In the event of overstaining this can be reduced by alternate immersion in 0·25 per cent potassium permanganate solution and Pal's fluid.

These observations, which are being published elsewhere in greater detail, suggest that this simple technique is a general nerve stain which gives constant results, and may prove a valuable additional neuro-histological tool for workers in similar fields. A limited examination of other tissues by this method, for example, dental pulp and skin, points towards unequivocal results being obtainable.

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Attempt to transplant the Œdema Fluid of Experimental Inflammatory Œdema in Rats

According to the literature, the materials suspected of being either the cause of, or an important participant in, the different types of acute experimental inflammatory œdema in animals include histamine, hydroxytryptamine, some peptides (for example, leukotaxine, etc., of Menkin[1]), spreading factors (for example, Duran-Reynals[2], McGovern[3]), the plasma protein permeability factor of Miles and Wilhelm[4], and also certain nucleic acid derivatives (Spector and Willoughby[5]). The presence of at least the first two important members of these substances in œdema induced by testicular extract of the rat's hind-paw was demonstrated by Rowley and Benditt[6] as well as in our laboratory. The histamine activity, for example, ranges from 2 to 10 μgm. in 1 ml. of œdema fluid.

An attempt was therefore made to transmit acute œdema of the rat's hind-paw in sixteen experiments carried out with young rats of 120–150 gm.; œdema was induced by testicular extract or a bacterial hyaluronidase preparation. Details of the method of production and estimation of the œdema induced by testicular extract have already been given[7]. For the bacterial preparation, 'Hyason' (Organon) was used in amounts of 75–150 T.R.U. to 0·1 ml. saline injected. Five to ten minutes after plantar induction, the gross, acute (protein-rich) œdema fluid can be readily obtained by puncture on the dorsal side where the clear fluid appears. After defibrination in a small test-tube with the aid of the puncture needle, 0·1 ml. of the œdema fluid is injected, within 2–4 min., into the opposite hind-paw of the same animal.

The released materials present in the standardized amount of 0·1 ml. of the injected œdema fluid fail to induce noteworthy œdema. On the other hand, the significance of local factors could be demonstrated: a local refractory period (4–8 hr. in our experiments) occurs after the acute inflammatory phase. Although the transplantation was seemingly effective in five out of the sixteen experiments, the presence of the œdema-inducing material was responsible for these positive cases, as demonstrated in controls in which a half or a third of the amount originally injected of testicular extract or bacterial hyaluronidase was able to produce remarkable œdema. The other eleven experiments were negative.

The role of a theoretical inhibitor, present in the œdema fluid as a product of natural defence, was

investigated. Amounts of bacterial preparation were dissolved (*a*) in the œdema fluid and (*b*) in saline, and were then injected simultaneously into the two hind-paws of the same animal. No difference was observed between the response of the two extremities in three experiments.

Substances released after the injections are obviously involved in the production of œdema, but the presence of certain amounts of exogenous œdema-inducing material is necessary to produce 'regular' œdema, despite the fact that released substances are present in the possible endogenous form and concentration. In fact, if the presence of injected œdema-inducing material were unnecessary, and the liberated endogenous substances could act alone, then we could expect that œdema fluid would be continuously transmissible. As we have shown, this is not the case. All the substances mentioned in the first paragraph could perhaps become 'œdema-inducing' if they were administered in excess amount or in excess volume. Naturally, there are species differences.

I suggest, therefore, that the production of œdema in the rat's hind-paw, at least, is a primary function of the currently used œdema-inducing substances.

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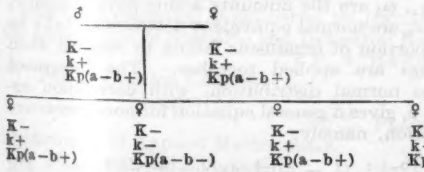
A 'New' Kell Blood-Group Phenotype

During the past year or more, Dr. Fred H. Allen, jun.[1,2], of the Blood Grouping Laboratory, Boston, has opened up the Kell blood-group system through the discovery of two antibodies additional to anti-K and anti-k, called anti-Kp^a and anti-Kp^b, which unquestionably define antigens in the Kell system. The former, he tells us, reacts with about two per cent of random bloods, while the latter reacted with all but 2 of 5,500. All bloods tested reacted with at least anti-K or anti-k and one of the new antibodies. In order to facilitate further investigation of the Kell system, Dr. Allen supplied certain laboratories, of which ours was one, with samples of these two antibodies. Having these to hand allowed us recently to define a new Kell phenotype, namely, K−, k−, Kp(a−b−), in two sisters. The Kell phenotypes of the family are as follows:



These have been confirmed both in Dr. Allen's laboratory and in that of Drs. Race and Sanger. The family is of Polish extraction. The parents are second cousins.

The propositus had been transfused in 1952; her blood contains antibodies of the Kell system, the exact specificity of which we have not yet been able to determine; her baby, born in 1957, suffered from hæmolytic disease of the new-born due to these antibodies, while she herself, given a bottle of K+, k+, Kp(a−b+), and a bottle of K−, k+, Kp(a−b+) blood, suffered a severe reaction with jaundice and oliguria. Her K−, k−, Kp(a−b−) sister was transfused in 1954; she has no Kell antibodies. At the time of the original transfusions, namely, in 1952 and 1954, each sister received blood from two donors; all four donors are K−, k+, Kp(a−b+).

The 'new' phenotype is put on record to further the study of the make-up of the Kell system.

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Differences in the Food of the Young and the Adult Indian Mackerel, *Rastrelliger kanagurta* (Cuv.)

The problem of the food of fishes with its varied bearings on their shoaling habits and migrations has engaged the attention of fishery biologists since the beginning of the present century. The mackerel is an important food fish in both hemispheres. Several contributions[1–5] have been made to our knowledge of the food of the Indian mackerel, *Rastrelliger kanagurta*, which contributes to one of the largest fisheries of India. All these observations, except those of Chacko[3], which are from the Gulf of Manaar, are confined to the west coast of India. According to these workers, mackerel is a noted plankton feeder, securing its food by filtration. Chidambaram[2], while observing the adult mackerel as plankton feeder, suggested the carnivorous habits of the young mackerel. Later, in a detailed account on the food of this fish, Bhimachar and George[4] observe that "the food of the young mackerel does not radically differ from that of the adult". Pradhan[5] has arrived at a similar conclusion regarding the food of mackerel; but one will not fail to note from his observations that young mackerel less than 89 mm. in total length are not represented in his material.

In the course of the present investigation, extending for more than a year, 593 mackerel belonging to all sizes ranging from 32 mm. to 243 mm. in total length have been collected from the Lawson's Bay landings near Waltair, and their food contents examined. From this analysis it became evident that mackerel of the size of 90 mm. and more in total length are plankton feeders, consuming large quantities of Protophyta (phytoplankton) along with some zooplankton. Further, it was noted that the adult mackerel is not an indiscriminate feeder. Though the proportions of the phyto- and zoo-planktonic elements in the stomach contents of this fish are more or less in accordance with their relative abundance in the plankton, a sort of selective feeding (avoidance) exists at least with regard to such macroplanktonic forms such as medusæ, ctenophores, salps and

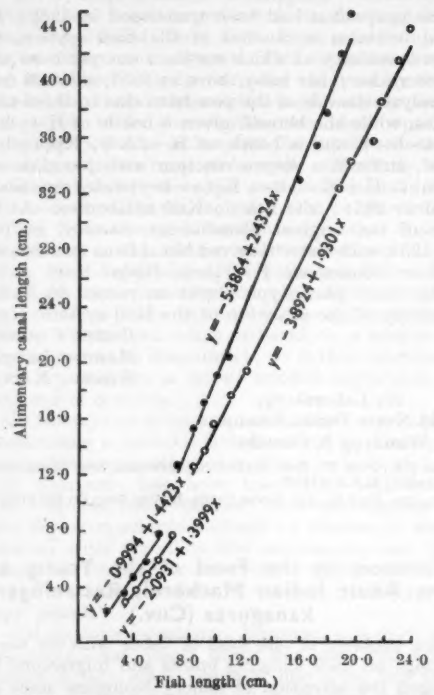

Fig. 1. Number of fish measured, 575; all measurements were grouped at 1-cm. class-intervals and each point represents the average value for each 1-cm. class. The straight line in each case represents the best fit as calculated from the equation given alongside.

Standard length against alimentary canal length, —●—●. Taking the first five values as normal (that is, $y = -0{\cdot}9994 + 1{\cdot}4423\,x$) the difference in slope between the first five and the remaining ten points is significant at the 5 per cent level of χ^2 for nine degrees of freedom.

Total length against alimentary canal length, —○—○. Taking the first five values as normal (that is, $y = -2{\cdot}0931 + 1{\cdot}3999\,x$) the difference in slope between the first five values and the remaining eleven points is significant at the 5 per cent level of χ^2 for eleven degrees of freedom

chaetognaths. In the stomach contents of mackerel of size-range 90–243 mm. total length, relatively little zooplankton was found and this consisted of the following forms: copepods, larval cirripeds, larval pelecypods, *Lucifer*, *Evadne* and larval crustaceans.

The food habits of juvenile mackerel ranging in total length from 32 to 90 mm. are different. The stomach contents of these juvenile fish showed that fish larvæ (*Anchoviella* species) form their staple food, and this is supplemented by the planktonic sergestid, *Lucifer*. In rare cases, copepods and a few Protophyta were noted in the stomach contents. These observations suggest that the juvenile mackerel are carnivorous and selective in their food habits.

While making biometrical studies on some marine fishes of the Waltair coast, we have observed an allometric growth in the alimentary canal of the mackerel. The relationship between the linear measurements of the alimentary canal and total and standard lengths of the mackerel is plotted in Fig. 1. It is clear from the graph that the relative length of the digestive tract is greater in the adult fish than in the juveniles. It is interesting to note that both the change in the food habits of the fish and the relative length of its alimentary canal take place at the same total length of fish. It is very likely that this change in the relative length of the alimentary canal of the mackerel is associated with the change in the food habits of the fish at about 90 mm. total length.

We thank Mr. K. Krishna Rao for his help in the statistical treatment of the results presented here.

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Quantal Responses to Mixtures of Drugs

The joint action of two drugs can be termed 'non-interactive' if, when applied together, neither modifies the physiological action of the other that leads to the response under consideration[1]. We have previously formulated the relation between dose and quantal response for the extreme forms of this type of joint action, namely, simple similar action[1], in which the drugs act on the same physiological system, and independent action[1,2], in which they act on different systems. The relation for independent action allowed different degrees of correlation of the tolerances for the respective drugs; but the relation for simple similar action allowed only their complete positive correlation. We have now extended this work, first to cover types of non-interactive joint action intermediate between the extreme forms, and secondly, to permit any degree of correlation of tolerances for every form of non-interactive joint action. Since interactive joint action can be formulated as a generalization of non-interactive[1], the whole theory of quantal responses to mixtures of drugs is thereby unified.

Our new general approach to the problem is to infer the conditions for non-response in the individual organism for every form of non-interactive joint action, and not as before to do this for independent action only. An outline of the more important results of this approach is given below, and details of the investigation will be published elsewhere.

Suppose that the relations between dose and response for the individual drugs are

$$x_1 = \varepsilon_1 + \theta_1 \log \omega_1 \qquad (1)$$

and

$$x_2 = \varepsilon_2 + \theta_2 \log \omega_2 \qquad (2)$$

where ω_1, ω_2 are the amounts acting physiologically, and x_1, x_2 are normal equivalent deviations. Let q be the proportion of organisms failing to respond when the drugs are applied together. The integrated bivariate normal distribution, with correlation coefficient ρ, gives a general equation for non-interactive joint action, namely,

$$q = \iint_R (2\pi)^{-1} (1 - \rho^2)^{-\frac{1}{2}} \exp[-(u^2 - 2\rho uv + v^2)/2(1 - \rho^2)]\, du\, dv \qquad (3)$$

where R is a region defined by

$$h_1(x_1 + u)/\theta_1 + \nu h_2(x_2 + v)/\theta_2 \leqslant 1 \qquad (4)$$

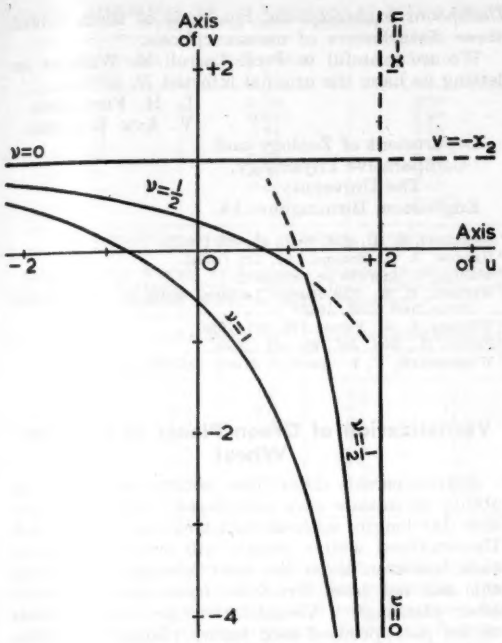

Fig. 1

and

$$\nu h^{(x_1+u)/\theta_1} + h^{(x_2+v)/\theta_2} \leqslant 1 \qquad (5)$$

Here h is the base of logarithms and ν is a parameter, ranging from 0 to 1, measuring the degree of similarity between the physiological actions of the two drugs. When $\nu = 0$, (3) is the equation for independent action that we obtained before; when $\nu = 1$, it is the equation for simple similar action.

Fig. 1 shows in plan exemplary regions of the bivariate normal surface defined by (4) and (5), and is comparable to a figure we gave before[2] to illustrate the regions for independent action. For Fig. 1, $x_1 = -2$, $x_2 = -1$, $\theta_1 = 4{\cdot}5$, $\theta_2 = 8$ and $h = 10$. The boundaries of integration are the continuous lines marked with the corresponding values of ν, namely, 0, $\frac{1}{2}$ and 1. The regions of integration lie to the left of and below the boundaries.

In the special case in which $\nu = 1$, and $\rho = +1$, (3) becomes

$$h^{(x_1-x)/\theta_1} + h^{(x_2-x)/\theta_2} = 1 \qquad (6)$$

where x is the normal equivalent deviation corresponding to $1 - q$. The equation that we put forward previously for simple similar action was (6) with the restriction that $\theta_1 = \theta_2$. Equation (6) with $\theta_1 \neq \theta_2$ accounts for some data[3] on the joint action of certain insecticides closely related chemically.

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Homoserine in Bleeding Sap of Pea Plants

In a recent paper[1], it was shown by means of paper chromatography that in bleeding sap of pea plants 5½ weeks old, inoculated with effective strains of *Rhizobium*, some amino-acids and amides occurred. The chief of these compounds proved to be aspartic acid, asparagine, glutamine and a substance giving a colour with ninhydrin, of which the R_F values on nearly all chromatograms corresponded with those of threonine. Only when using phenol/water as solvent was a somewhat higher R_F value found. The other solvents used were: collidine/water; butanol/acetic acid/water; propanol/water[2].

In an attempt to identify the spot, the following solvents were used: 'Methylcellosolve' (ethyleneglycol monomethylether)/water[3]; methanol/water/pyridine[4]; *tert.*butanol/methylethylketone/water/diethylamine[4]. Of these three solvents, only the latter produced for the unknown substance an R_F value deviating from that of threonine, as phenol/water did.

By comparing a mixture of known amino-acids (including homoserine) with the substance on the chromatograms, and by adding homoserine to the bleeding sap before running the solvents, the unknown spot was finally identified[5–9] as homoserine (an isomer of threonine).

This homoserine was found for the first time in 1953 by A. I. Virtanen and co-workers[5,6] to be one of the principal free amino-acids (70 per cent ethanol-extract) occurring in pea plants. Later on it was found by Virtanen and co-workers[7] to occur as such also in other plants (even in non-legumes) although in smaller quantities.

The procedure described above proves that for chromatographical identification of amino-acids in fluids of unknown composition, it is imperative to determine R_F values in several different solvents (five at the least), before deciding upon the identity of a spot.

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Abnormal Metamorphosis in Saturniid Moths infected by a Microsporidian

Deviations from the normal course of metamorphosis in insects may be caused by parasitic infections[1,2]. In studies on a microsporidian of the genus *Nosema*, found in *Hyalophora* (*Platysamia*) *cecropia* and afterwards sub-cultured in *Antheraea polyphemus* and *A. pernyi*[3], seventeen of the many infected animals failed to metamorphose normally. The most severely affected were adults of *H. cecropia*. They retained a number of pupal structures. The

tip of the abdomen and the genitalia were pupal in form; the cuticle of the rest of the abdomen and of the thorax was a mosaic of pupal and adult types and at the base of each eye was an unpigmented band. Such abnormalities can be produced experimentally by introducing active corpora allata or juvenile hormone (neotenin) into the developing adult during the period when its own corpora allata are inactive[4,5]. Lesser effects were seen in two *A. pernyi* pupæ that had been formed from infected larvæ. Each had white, larval-type setæ scattered over the abdomen, and crotchets in the position of the larval prolegs. Finally, there were adults of both species of *Antheraea* which had patches of pupal-type cuticle.

The results have shown that the parasite apparently upsets the endocrine balance in the host and this leads to a repetition of structures at metamorphosis. Similar effects were produced by Piepho[6] in *Galleria* and by Wigglesworth[7] in *Rhodnius*. They obtained localized repetitions over the sites of implanted corpora allata. Williams[5] has shown that adult male *H. cecropia* have stores of corpus allatum hormone in most tissues of the body, but in highest concentration in the abdomen. Perhaps tissues damaged by parasitic invasion release their hormone. Our *Nosema* sp. is often very unevenly distributed in the host, and although it is primarily a parasite of gut epithelium and a muscle, it will invade silk-glands, fat-body, Malpighian tubules, pericardial cells, brain and nerve-cord. Host cells become hypertrophied and their nuclei begin to disintegrate though the latter are never actually invaded. Later, the cell walls may break down.

Williams[5] could find no juvenile hormone in adult females of *H. cecropia* or in adults of either sex of *A. polyphemus*. In our experiments both sexes of all three species have been metathetelic. Two *A. polyphemus* adults were almost as severely affected as the *H. cecropia*, but most of the *A. polyphemus* and all the *A. pernyi* were only slightly affected. Williams could extract the hormone in appreciable amounts from the abdomen only. In our experiments the abnormalities shown by the *A. pernyi*, which is the least responsive species, were confined to the abdomen. A possible explanation is that there is a decreasing concentration of juvenile hormone in the tissues of the three species in the following order: *H. cecropia* → *A. polyphemus* → *A. pernyi*.

It would appear from Williams's results that there is also a difference between sexes, but we have seen no indication of such a difference. If our hypothesis is correct, it means that the microsporidian is a more sensitive indicator of juvenile hormone than Williams's methods of extraction. An obvious objection to our explanation is that the corpora allata were present in the experimental animals. However, in view of the very localized effects, it is unlikely that the corpora allata were simply over-active. An experiment to settle this doubt would be the removal of corpora allata, followed by infection with the microsporidian. One metathetelic adult has in fact been produced from such an allatectomized pupa, but we cannot draw any conclusions from an isolated result. We put it on record because it is unlikely that further experiments can be carried out in the immediate future.

We have succeeded in infecting *Saturnia pavonia*, *Arctia caja*, *Cerura vinula*, *Selenia bilunaria*, *Sphinx ligustri*, *Pieris brassicae*, *Vanessa io* and the blowfly *Calliphora erythrocephala*, but none of them showed these disturbances of metamorphosis.

We are grateful to Prof. Carroll M. Williams for letting us have the original infected *H. cecropia*.

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Vernalization of Green Plants of a Winter Wheat

Spring cereals differ from winter cereals in their ability to initiate ears immediately under a favourable day-length, without cold treatment of the seed. Unvernalized winter cereals will eventually initiate ears, but even under the most favourable conditions this has not been found to occur until 6–8 weeks after planting[1]. 'Vernalization' or cold treatment of the just-sprouted seed before planting will eliminate this period of delay before ear initiation, and field studies certainly suggest that the growing plant is also capable of responding to cold treatment during this period[2–4]. However, direct evidence of the response of the green plant of the winter cereal to cold treatment is scanty. (Possibly Gunar and Krastina[4] have evidence on this point, but this is not clear from the abstract available to me.)

A previous attempt[7] at cold treatment of seedlings of 'Petkus' winter rye had suggested that vernalization of the green plant might not be possible, but these experiments were carried out at very low light intensity; therefore, in 1955, using a controlled environment cabinet, the experiment was repeated, using whole plants of various ages of an Australian winter wheat, Winter Minflor.

Plants aged 2–44 days, previously grown at greenhouse temperatures never falling below 12° C., were treated for 48 days at a temperature of 3° C. (± 1·5°). Control plants were retained in the greenhouse. Continuous light, which is the most favourable regime for eventual flowering of unvernalized winter rye[1], was maintained for both treated and control plants throughout. Growing points were dissected before and after treatment (Tables 1 and 2). By the end of the period of cold treatment the oldest control plants (99 days) were already beginning to initiate ears, without having experienced any low-temperature treatment. All other plants were completely vegetative, the apices of the cold-treated plants being consistently shorter than those of the controls (Table 1). The increase during treatment of the total number of primordia present on the main shoot is shown in Table 2. The cold-treated plants grew more slowly than the controls, and older plants more slowly than younger ones under both treatments. The longer apices and greater number of primordia of the oldest set of controls is due to the rapid increase in growth-rate of the apex after initiation[1].

Table 1. APEX-LENGTH (MM.) OF MAIN SHOOT OF WINTER MINFLOR WHEAT AFTER COLD TREATMENT

Age when treated (days)	Cold treated V	Control C
2	0·19	0·29
7	0·25	0·29
14	0·27	0·28
22	0·30	0·33
29	0·29	0·36
36	0·31	0·35
44	0·34	0·39
51	—	0·89*

* Reproductive apices. V, vernalized; C, control.

Table 2. TOTAL NUMBER OF PRIMORDIA PRESENT ON MAIN SHOOT OF WINTER MINFLOR WHEAT BEFORE COLD TREATMENT, AND INCREASE DURING 48 DAYS TREATMENT

Age when treated (days)	Before treatment		Increase during treatment	
	V	C	V	C
2	4·0	4·0	4·6	11·8
7	5·0	5·0	6·7	11·6
14	7·5	7·6	5·5	9·6
22	9·8	10·0	4·4	8·5
29	11·6	11·6	4·6	7·7
36	13·4	12·8	3·3	6·2
44	15·4	15·0	1·9	5·7
51	—	17·0	—	8·0*

* Reproductive apices

In the week after the end of the treatment, all cold-treated plants formed spikelet primordia, irrespective of the age at which the cold treatment had commenced, and all these plants afterwards flowered almost simultaneously (Table 3, col. 3). The small standard errors with the cold-treated plants are characteristic of full vernalization. The earlier flowering of the cold-treated plants is also reflected in the lower leaf numbers on the main axis before ear formation (Table 3, cols. 7 and 8).

Table 3. VERNALIZATION OF WHOLE PLANTS OF WINTER MINFLOR WHEAT AT VARIOUS AGES

Age when treated (days)	No. of emerged leaves	Days from end of treatment to anthesis (with standard error)				Final leaf No.	
		V	S.E.	C	S.E.	V	C
2	0	39·9	0·13	62·6	1·98	7·7	12·6
7	1·5	38·8	0·20	57·5	2·59	8·3	12·9
14	3·0	38·4	0·22	62·0	0·95	9·0	14·0
22	4·0	37·3	0·23	54·1	2·44	10·0	14·1
29	4·9	36·3	0·32	47·6	2·75	10·3	13·4
36	5·1	36·3	0·33	45·0	3·12	10·9	13·0
44	6·4	37·5	0·59	43·9	2·23	11·6	13·8
51	7·3	—	—	34·3	1·57	—	14·5

Control plants of the younger series flowered much later than those vernalized, but this difference gradually decreased as the age at treatment increased and the plants approached the age when flowering would have occurred normally (Table 3, col. 5). It is clear that a 48-day cold treatment given to plants older than seven weeks would only have succeeded in delaying the anthesis of the treated plants by comparison with the controls.

Thus the winter wheat Winter Minflor is capable of vernalization at any stage from the just-germinated seed up to a 6-weeks old plant with 6–7 leaves on the main shoot, despite earlier growth above vernalizing temperatures.

In the unvernalized control plants, the substance *B* produced by the vernalization reactions[8]

$$A \rightleftharpoons A' \rightarrow B$$

is slowly accumulating even under high-temperature conditions, and in this experiment reached a level comparable with the fully vernalized plant at about 90 days after planting. Therefore it is likely that the older the plant the shorter the period of cold treatment necessary for complete vernalization.

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Cytology of Indian Species of *Onychium*

THE fern genus *Onychium* Kaulf. is primarily an old-world representative of Bower's[1] primitive gymnogrammoids. Excepting Bower[1] and Holttum[2], there is a general agreement in the pteroid affinity of the genus; but its exact phyletic treatment, however, differs considerably in the various systems of classifications[1–5].

Ching[3] reports six species of the genus from east Asia whereas Copeland[4] refers to three to six species in the Old World. Christensen[6] recognizes seven species excluding the three Chinese ones described later by Ching[7]. From the accounts of Clarke[8], Beddome[9] and Stewart[10], it seems that of the six East Asian species three are represented in the Himalayan region. While a full report on the detailed cytomorphological investigations awaits publication, this communication records only the cytological observations. Fixations were made both in Carnoy's (1 : 3 : 4 acetic/alcohol/chloroform) and 1 : 3 acetic/alcohol, and the usual acetocarmine squash technique employed. It is experienced that Carnoy's fixation yields better results with the present material.

Onychium auratum Kaulf.[4] (*O. siliculosum* (Desv.) C.Chr.[6]). The type species of the genus is reported to occur from Japan to India, and the present material was collected from various localities in Darjeeling and Sikkim Himalayas at lower altitudes. It is one of the commonest rock-dwelling ferns, mostly associated with *Pteris vittata* L. and *Pityrogramma calomelanos* (L.) Link. The species exhibits a great variation in its size, ranging from 1 to 4 ft.; but at diakinesis, irrespective of the size, in all cases 29 bivalents have been counted (Fig. 1). Further, it is quite reasonable to assume from the field observations that variation in size can be related to shade and moisture conditions. Meiosis is perfectly regular and results in the production of 64 spores per sporangium.

O. japonicum (Thbg.) Kunze. The species has been studied from Mussoorie and Sikkim Himalayas. There is a great uniformity of frond form and the gametic number from the diakinesis counts is 29. Normal tetrad formation yields 64 spores.

O. contiguum (Wall.) Hope[7] (*O. lucidum* (Don.) Spr.[10]: syn. *O. japonicum* var. *multisecta* F. Henderson ex Clarke[10], *O. japonicum* var. *lucidum* Christ.[10], *O. cryptogrammoides* Christ.[7], and *O. japonicum* var.

Fig. 1. Diakinesis in a spore mother cell of *Onychium auratum* Kaulf. showing $n = 29$

intermedia Clarke[7]). The present material was collected near Tonglu Dak Bungalow (10,000 ft. alt.) on the Indo-Nepal border (Dist. Darjeeling). Meiosis, as studied from a large number of spore mother cells, reveals in each case 58 bivalents (Fig. 2) and is absolutely normal. In practically all the cases studied only eight mother cells are produced in a sporangium and 16-celled ones appear to be absent. The 8-celled sporangia later result in 32 spores, relatively much bigger than in the other two species. A somatic count of about 58 has also been possible from a young uncurling frond tip. It thus now becomes evident that it is a well-established obligate apogamous species and the doubling in the chromosomes could take place by the failure of premeiotic mitosis, followed by a regular course of meiosis resulting in unreduced spores. Further studies on spore germination, sporogenesis and taxonomy of the species are in progress.

The foregoing account clearly reveals that the basic number for the genus is 29, and of the three Himalayan species two are diploid and one diploid apogamous. It is significant to note here that this number is in line with other pteroid, adiantoid and cheilanthoid members reported earlier[11,12], and is equally shared by Holttum's[4] Adiantaceae and Pteroideae. Of Bower's[1] primitive gymnogrammoids, excluding *Cer-*

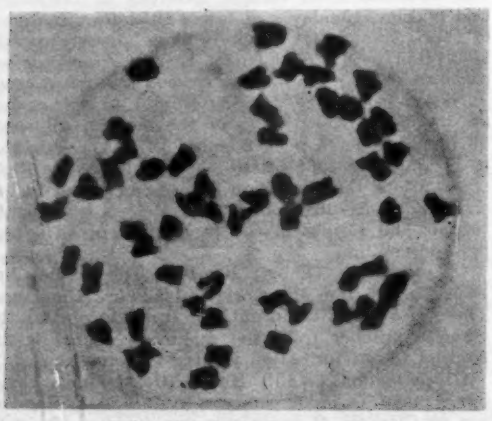

Fig. 2. Metaphase of the first meiotic division in a spore mother cell *Onychium contiguum* (Wall.) Hope showing $n = 58$

atopteris (discussed in detail by Ninan[13]), previously the cytology of *Cryptogramma* only was known ($n = 30$), which, however, exhibits the same variance as presented by adiantoid and cheilanthoid members. Furthermore, it seems pertinent to add that Bower's[1] contention of the origin of *Onychium* and related genera from some fern similar to *Todea* (osmundaceous stock, $n = 22$)[11], later supported by Holttum[2], remains still debatable and is discussed elsewhere.

We wish to express our thanks to Dr. C. V. Morton for general help in collecting fern literature.

P. N. Mehra
S. C. Verma

Department of Botany,
Panjab University,
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May 2.

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The 'Dawn Chorus' in Radio Observations

In his communication in *Nature* of August 31, p. 433, Mr. J. H. Pope implies that the name 'dawn chorus' was given to the phenomenon in the audio-frequency range to which he refers because of its occurrence at dawn. It was used many years ago by the late K. W. Tremellen, who to the best of our belief originated it. Certainly we know that in using it he had in mind the fact that the phenomenon sounds like the twittering of birds in their dawn chorus so characteristic of the English countryside.

When L. R. O. Storey was making his study of 'whistlers' at Cambridge, Mr. Tremellen lent him his file of papers on the subject and discussed the 'dawn chorus' with him. It is thus certain that Storey adopted the name from him and appreciated that the reference was to the similarity in sound of this 'whistler' phenomenon to the dawn chorus of the birds. In fact, in his paper[1] he says that the sound may be likened to that of a rookery heard from a distance.

Mr. Tremellen was well aware that the phenomenon was not confined to the dawn. Mr. Pope's suggestion that it should be called simply the 'chorus' obscures the origin and purpose of the name, and we plead that it should be retained with a reference, if necessary, to its true significance in relation to the characteristic sound of the phenomenon.

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Marconi's Research Laboratories,
Great Baddow,
Essex.

[1] Storey, L. R. O., *Phil. Trans. Roy. Soc.*, A, **246** 113 (1953).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 7

INSTITUTION OF CHEMICAL ENGINEERS (in the Council Chamber, Federation of British Industries, Tothill Street, London, S.W.1), at 5.30 p.m.—Symposium on "The Effect of Temperature on Bursting Discs".

UNIVERSITY OF LONDON (in the Assembly Hall, Institution of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. C. G. Nobbs: "Mathematics".* (First of a series of lectures on "Contemporary Ideas on Teaching Method".)

Tuesday, October 8

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. G. P. Wells, F.R.S.: "The Evolution of Lugworms".*

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. K. Lewis: "Investigation of Rainfall, Runoff and Yield on the Alwen-Brenig Catchments".

Wednesday, October 9

BRITISH FLAME RESEARCH COMMITTEE (in collaboration with the INSTITUTE OF FUEL, at the Institute of Civil Engineers, Great George Street, London, S.W.1), at 10 a.m.—Symposium on "Flames and Industry".

PHYSICAL SOCIETY, COLOUR GROUP (in the Lecture Theatre of the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Mr. B. O. Smith: "Colour and Steelmaking".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—General Meeting.

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Debate on the Motion "That the Population of the United Kingdom should be Stabilized at 40 Millions". Speakers: Proposers—Mr. C. P. Blacker and Mrs. Margaret Pyke; Opposers: Capt. R. A. Pilkington, M.C., M.P., and Mr. Peter R. Cox.

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON GRADUATE AND STUDENT SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.—Mr. F. L. Fielding: "TACAN—a New Air Navigational System" (Chairman's Address).

SOCIETY FOR ANALYTICAL CHEMISTRY, BIOLOGICAL METHODS GROUP (in the restaurant room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion Meeting on "Biological Standards".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. J. B. Cotton and Mr. H. Bradley: "The Corrosion Resistance of Titanium".

Thursday, October 10

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. W. T. Stearn: "A Botanist's Impressions of Jamaica, British West Indies"; Mr. J. Gordon Blower: "British Millipedes".

UNIVERSITY COLLEGE, LONDON (in the Gustav Tuck Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. Hans Ramberg (University of Chicago): "The Origin of Pegmatites in West Greenland"* (Further lecture on October 11).

Friday, October 11

BRITISH MYCOLOGICAL SOCIETY (in the Physics Lecture Theatre, Birkbeck College, Malet Street, London, W.C.1), at 11 a.m.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. B. Lythgoe: "Recent Advances in the Chemistry of Vitamin D".

Saturday, October 12

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION, SOCIAL PSYCHOLOGY SECTION; and the COMMITTEE OF PROFESSIONAL PSYCHOLOGISTS (MENTAL HEALTH) (at the University of London Institute of Education, Malet Street, London, W.C.1), at 10.30 a.m.—Symposium on "Secondary School Selection: Social and Education Issues behind the 11+ Examination".*

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. F. N. Ghadially: "The Technique of Breeding Tropical Fishes".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH ASSISTANT (with a first- or second-class honours degree in either botany or zoology) IN THE DEPARTMENT OF BOTANY AND ZOOLOGY—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (October 11).

ASSISTANT IN THE DEPARTMENT OF NATURAL PHILOSOPHY—The Secretary, The University, Edinburgh (October 12).

LABORATORY STEWARD (familiar with the maintenance and preparation of general equipment and materials for chemistry and physics)—The Registrar, North Oxfordshire Technical College and School of Art, 51 The Green, Banbury, Oxon (October 12).

SENIOR LECTURER (academically well qualified and prepared to conduct postgraduate work in radio chemistry and/or analytical chemistry) IN THE DEPARTMENT OF CHEMISTRY AND BIOLOGY—H. S. Magnay, M.A., College of Technology, 14 Sir Thomas Street, Liverpool 1 (October 12).

RESEARCH FELLOW (preferably with research experience in physical and inorganic chemistry) IN THE DEPARTMENT OF CHEMISTRY, to study the chemistry of molybdenum and tungsten—Prof. R. S. Nyholm, University College, Gower Street, London, W.C.1 (October 14).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, King's College, Strand, London, W.C.2 (October 15).

RESEARCH ASSISTANT (graduate with research experience) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Hull (October 19).

SENIOR LECTURER or LECTURER (British subject, with a first- or second-class honours degree in mathematics, and preferably some teaching experience) IN THE MATHEMATICS DEPARTMENT—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (October 24).

LECTURER or ASSISTANT LECTURER IN CHEMISTRY IN THE DEPARTMENT OF VETERINARY PHYSIOLOGY—The Secretary, Royal Veterinary College, Royal College Street, London, N.W.1 (October 31).

LECTURER or SENIOR LECTURER IN APPLIED MATHEMATICS at the University of New England, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

POSTDOCTORAL RESEARCH FELLOW IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (October 31).

READER IN APPLIED MATHEMATICS; an ASSISTANT LECTURER (Grade B) IN PURE MATHEMATICS; and an ASSISTANT LECTURER (Grade B) IN APPLIED MATHEMATICS—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (October 31).

LECTURER and an ASSISTANT LECTURER IN PHYSICS—The Deputy Registrar, The University, Birmingham (November 1).

RESEARCH OFFICER (CEREAL CHEMISTRY) IN THE DEPARTMENT OF AGRICULTURE, Agricultural Research Institute, Wagga, N.S.W., Australia—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (November 1).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree or equivalent qualification) IN THE DEPARTMENT OF GENETICS—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (November 5).

BIOMETRICIAN (preferably with full technical training and experience, both in mathematical statistics and in agriculture) in the New South Wales Department of Agriculture, Australia, to act as a general consultant on the design of experiments, and make or supervise statistical analysis of research results—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (November 9).

READER IN THE DEPARTMENT OF PHYSIOLOGY, John Curtin School of Medical Research, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 11).

LECTURER IN PHYSIOLOGY—The Secretary, Queen's University, Belfast (November 15).

READER, SENIOR LECTURER or LECTURER IN PHYSIOLOGY AND BIOCHEMISTRY in the Faculty of Veterinary Science; and a SENIOR LECTURER or LECTURER IN ANATOMY, at the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 15).

SENIOR LECTURER IN AGRICULTURAL CHEMISTRY at the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 15).

CHAIR OF ARCHÆOLOGY (with special reference to Wales)—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (November 23).

AGRONOMIST (with a university degree in horticulture with practical experience, and preferably a knowledge of statistical methods) in the Somaliland Protectorate, to investigate the possibilities of growing a large range of tropical and semitropical fruits, vegetables and field crops including dates, citrus, lucerne, sorghum and possibly cotton—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/5/04.

ASSISTANT, Grade B (with a good honours degree), FOR MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex.

ASSISTANT LECTURER IN THE DEPARTMENT OF MECHANICAL, CIVIL AND CHEMICAL ENGINEERING, to assist in the development of courses in aircraft structures—The Secretary-Treasurer, The Royal College of Science and Technology, George Street, Glasgow, C.1.

EXPERIMENTAL OFFICER (graduate in agriculture) IN THE FIELD EXPERIMENT SECTION, to assist with the field experiments and demonstrations to farmers—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

HEAD (with high academic qualifications in mathematics with teaching and research or industrial experience) OF THE DEPARTMENT OF MATHEMATICS—The Principal, Technical College, Queen Street South, Huddersfield.

LECTURER IN INVERTEBRATES IN THE ZOOLOGY DEPARTMENT, College of Arts and Science, Baghdad, Iraq—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

LECTURER (man or woman, with sound academic qualifications and teaching experience) IN CHEMISTRY—The Warden, Goldsmiths' College (University of London), New Cross, London, S.E.14.

LECTURER (with a degree or equivalent professional qualifications, together with some teaching and industrial experience) IN ELECTRICAL ENGINEERING at the Norwich City College and Art School, Ipswich Road, Norwich—The Director of Education, City Hall, Norwich.

MATHEMATICAL PHYSICISTS or MATHEMATICIANS, Principal Scientific/Senior Scientific/Scientific Officer grades (with a first- or second-class honours degree in mathematics or mathematical physics), to work in one of the following fields: astrophysics; atmospheric diffusion; stochastic theory; statistical, fluid, solid or general applied mechanics; and numerical analysis for large digital computers—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1580/34.

MEDICAL PHYSICIST at the Lincolnshire Radiotherapy Centre—The Group Secretary, Scunthorpe Hospital Management Committee, War Memorial Hospital, Scunthorpe.

NON-MEDICAL BIOCHEMIST (Basic grade)—The Secretary, St. George's Hospital, Lincoln.

PLANT TAXONOMIST in the Ministry of Agriculture, Government of Iraq—The Director-General of Agriculture, Baghdad, Iraq.

RESEARCH ASSISTANTS (honours graduates) IN (*a*) PHYSICS AND (*b*) TELECOMMUNICATIONS—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18.

TECHNICIAN (male or female) IN THE PHYSICS DEPARTMENT, to assist in work on the therapeutic use of radioactive substances and X-rays—The House Governor, Royal Marsden Hospital, Fulham Road, London, S.W.3.

SCIENTIFIC ASSISTANT (preferably with a Ph.D. in biochemistry and some experience with proteins), for research work on intrinsic factor—The Registrar, King's College, Newcastle-upon-Tyne.

SCIENTIFIC OFFICERS (Ref. C.572/7A) (with a first- or second-class honours degree in engineering, physics or mathematics or equivalent); and ASSISTANT EXPERIMENTAL OFFICERS (Ref. C.587/7A) (with G.C.E. (advanced level) in mathematics and science) AT THE MECHANICAL ENGINEERING RESEARCH LABORATORY, D.S.I.R., Kilbride, Glasgow, for work on fluid flow, heat-transfer, lubrication, materials and mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

REPORTS and other PUBLICATIONS

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Journal of Microbiology, Epidemiology and Immunobiology. Vol. 28, No. 1. (English edition of a Russian journal.) Pp. 164. Published monthly. Approximately 2,000 pages per annum. Annual subscription price: £18; 50 dollars. (London and New York: Pergamon Press, 1957.) [237

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Carnegie Institution of Washington. Publication 613: The Political Geography of the Yucatan Maya. By Ralph L. Roys. Pp. iv+187+17 maps. (Washington, D.C.: Carnegie Institution of Washington, 1957.) Cloth, 2 dollars; Paper, 1.60 dollars. [247

Report of the Advisory Committee enquiring into Production Development and Consumption Research in the Natural Rubber Industry. Pp. v+49. (Kuala Lumpur: Rubber Producers' Council of the Federation of Malaya, 1957.) 2 Malayan dollars. [297

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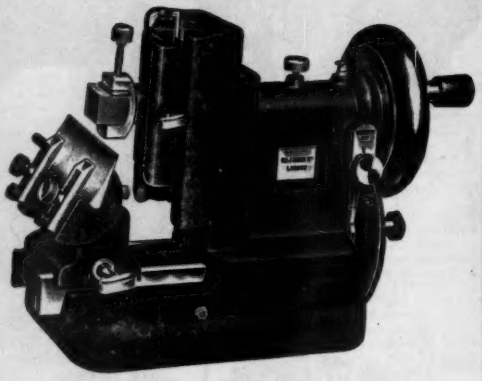

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